Shell Canada Limited

Application for the Approval of the

Pierre River Mine Project
Volume 2: Project Description

December 2007

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December 20, 2007

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Dear Sirs:

Re: Applications for Approval of the Jackpine Mine Expansion and Pierre River Mine

Shell Canada Limited (Shell) is hereby making a single submission of two separate applications for approval of the Jackpine Mine Expansion Project and the Pierre River Mine Project. The submission includes the Environmental Impact Assessment (EIA) of both projects in a combined documentation package.

Specifically, in accordance with the enclosed application and EIA, Shell is applying to:

- the Alberta Energy and Utilities Board, pursuant to the *Energy Resources Conservation Act* (ERCA) and Section 13 of the *Oil Sands Conservation Act* (OSCA), to amend the Jackpine Mine – Phase 1 Approval No. 9756 for approval to access additional mining areas on Oil Sand Leases 7277080T13 (Lease 13), 728101AT36 (Lease AT36), 7288080T88 (Lease 88), 7288080T89 (Lease 89), 7405120015 (Lease 015) and 7405090631 (Lease 631), and to modify and add processing units to the Jackpine Mine – Phase 1 oil sands processing facilities, located about 70 km north of Fort McMurray, Alberta. The expected processing capabilities of these modifications and additions will increase the average nominal capacity of the facilities by 5.8 million m^3/a (36.5 million bbl/yr), or 15,900 m^3/d (100,000 bbl/d) of dry bitumen, for a total average nominal capacity of the expanded facilities of 17.4 million m^3/a (109.5 million bbl/yr), or 47,700 m^3/d (300,000 bbl/d) of equivalent dry bitumen.

- the Alberta Energy and Utilities Board, pursuant to the *Energy Resources Conservation Act* (ERCA) and Section 13 of the *Oil Sands Conservation Act* (OSCA), for approval to construct and operate an oils sands mine and bitumen extraction plant and associated facilities on Oil Sand Leases 740012009 (Lease 9) and 7401100017 (Lease 17), to be known as the Pierre River Mine, located about 90 km north of Fort McMurray, Alberta and to the west of the

Athabasca River. The expected production rate from the project area is 11.6 m^3/a (73 million bbl/yr), or 31,800 m^3/d (200,000 bbl/d) of equivalent dry bitumen.

- the Alberta Energy and Utilities Board, to receive third party oil sands material (mined ore or intermediate process streams, such as bitumen froth) at the Jackpine Mine Expansion and Pierre River Mine facilities for processing.

- the Alberta Energy and Utilities Board, to produce and ship oil sands material (mined ore or intermediate process streams, such as bitumen froth) from the Jackpine Mine Expansion and Pierre River Mine facilities for processing at third-party facilities.

- Alberta Environment, pursuant to sections 67 and 70 of the *Environmental Protection and Enhancement Act* (EPEA) for an amendment and renewal of the Jackpine Mine – Phase 1 10-year operating approval (No. 153125-00-00 as amended), for the Jackpine Mine Expansion.

- Alberta Environment, pursuant to sections 49, 50, 51, 54 and 59 of the *Water Act,* for an amendment and renewal of an existing licence to divert water for use at the Jackpine Mine Phase – 1 Project and a new licence to divert additional quantities of water from the Athabasca River and other surface and groundwater sources for the Jackpine Mine Expansion, as set out in the application documents.

- Alberta Environment for approval, pursuant to section 66 of the *Environmental Protection and Enhancement Act* (EPEA), to develop the Pierre River Mine in accordance with the environmental plans and specific applications described in this submission.

- Alberta Environment, pursuant to sections 49, 50 and 51 of the *Water Act,* for a licence to divert water from the Athabasca River and other surface and groundwater sources for use at the Pierre River Mine, as set out in the application documents.

In support of these applications, Shell submits the enclosed documents entitled A*pplication for Approval of the Jackpine Mine Expansion Project* and *Application for Approval of the Pierre River Mine Project*. In accordance with the provisions of Division 1, Part 2 of EPEA and the *Terms of Reference* issued by Alberta Environment on November 28, 2007, an EIA has been prepared. The results of the EIA are reported in the enclosed documentation.

The application consists of the following:

- Volume 1: Project Description of the Jackpine Mine Expansion Project, which contains the technical and other information required to be filed in support of the amendment application to the Alberta Energy and Utilities Board, pursuant to OSCA, as well as the amendment application to Alberta Environment pursuant to the EPEA.

- Volume 2: Project Description of the Pierre River Mine Project, which contains the technical and other information required to be filed in support of a new application to the Alberta Energy and Utilities Board, pursuant to the OSCA, as well as an application to Alberta Environment pursuant to the EPEA.

- Volume 3: Environmental Impact Assessment - Introduction, Air Quality, Noise and Environmental Health

- Volume 4A: Environmental Impact Assessment – Aquatic Resources
- Volume 4B: Environmental Impact Assessment – Aquatic Resources Appendices
- Volume 5: Environmental Impact Assessment – Terrestrial Resources and Human Environment

Shell respectfully submits that the proposed projects are in the public interest, considering their social, environmental and economic effects, all of which are described in the enclosed documents.

Shell is committed to cooperating with stakeholders and other developers in the region to promote orderly and efficient development of the Athabasca oil sands resource in an economic and environmentally acceptable manner.

Shell will continue to work with local communities concerning the development of its plans, in an effort to develop mutually prosperous, long-term relationships with its neighbours.

Please direct all communications regarding the enclosed applications, to:

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Yours truly,

Shell Canada Limited

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Encl.

cc. File

APPLICATION FOR APPROVAL OF THE PIERRE RIVER MINE PROJECT VOLUME 2: PROJECT DESCRIPTION

EXECUTIVE SUMMARY

REQUESTED AMENDMENT

Shell Canada Limited (Shell) is applying to the Alberta Energy and Utilities Board (EUB) and Alberta Environment (AENV) for an approval to develop a new mining area, the Pierre River Mine. This new development will produce up to 31,800 m^3/cd (200,000 bbl/cd) of bitumen and will include a new mining area and associated processing facilities, utilities and infrastructure.

REGULATORY SUBMISSION APPROACH

To provide the most comprehensive view of Shell's regional plans, a single regulatory submission, consisting of two applications, is being filed:

- Volume 1: Jackpine Mine Expansion Project
- Volume 2: Pierre River Mine Project

The Jackpine Mine Expansion is being applied for as an amendment to the currently approved Jackpine Mine – Phase 1 Project. The Pierre River Mine is a new development, north of the Jackpine Mine, which will produce 31,800 m^3/cd (200,000 bbl/cd) of bitumen. These two applications are supported by one Environmental Impact Assessment (EIA) covering both projects.

This single submission covers all of Shell's currently defined resources and presents a long-term, comprehensive picture of Shell's development plan for the area, consistent with the expectations of regulators and stakeholders regarding long-term disclosure.

SCOPE OF THE PROJECT

The Pierre Rive Mine Project will involve:

- establishing the mine operations on Lease 9 with some additional facility construction activities on other leases
- building site access infrastructure, including a bridge across the Athabasca River
- constructing ore handling, conditioning and bitumen extraction facilities and a high-temperature froth treatment facility at the Pierre River Mine site

SCOPE OF THE PROJECT (cont'd)

- constructing a new raw water intake facility
- constructing a new external tailings disposal area (ETDA) at the boundary of Lease 17 and Lease 351 to accommodate the initial volume of tailings produced.

The project facilities will be located in a single plant site area in the northeastern corner of Lease 9. The process facilities will consist of two similar ore processing trains, which will include:

- crushers and conveyors
- slurry conditioning and ore preparation
- extraction
- tailings handling and treatment
- froth treatment
- solvent recovery
- tailings solvent recovery

Other facilities will include:

- administration buildings
- mine offices
- utilities and infrastructure

PROCESS DESCRIPTION

The process configuration and technology of the new facilities will be the same as those proposed for the Jackpine Mine. Bituminous ore will be reduced in size, conditioned and transported using hot water, so that the bitumen extraction occurs in a primary separation cell (PSC) at a temperature between 40°C and 50°C. Primary and secondary flotation will be used to increase bitumen recovery. Water and heat will be recovered in the thickener overflow. Thickened tailings will be pumped to the external tailings disposal area.

The extracted bitumen froth will be screened to remove solids and processed using a high-temperature froth treatment process. The final product will be a partially deasphalted bitumen that is virtually water and solids free, mixed with 30% solvent to reduce its viscosity for transport. The solvent used for transport will be removed at the Scotford Upgrader near Fort Saskatchewan, Alberta, and returned for use at the Pierre River Mine.

Solvent will be recovered from the froth treatment tailings using a tailings solvent recovery unit (TSRU) similar to that used at the Muskeg River Mine. Tailings from the froth treatment and extraction processes will be stored initially out of pit in a combined tailings disposal area. When there is sufficient space in the mined area and the first in-pit dyke has been completed, tailings streams will be directed to the mine, primarily as a non-segregating tailings (NST) mix.

MARKET

Clean bitumen will be transported to new facilities in the Scotford area near Fort Saskatchewan. Market opportunities for the crude oil products from these facilities will include synthetic crude oil and bitumen supply for:

- Shell's Scotford and Sarnia refineries
- refineries in the US Midwest
- emerging markets on the US west coast and offshore, including the Far East

PROJECT SCHEDULE

Detailed engineering and procurement of long-lead-time items will begin when regulatory and financial approvals have been received. Construction of the facilities required to gain access to the Pierre River Mine area could begin in 2010. Start-up of the first ore process train is planned for around 2018. Opportunities for integration and optimization with existing facilities will be pursued throughout the remainder of the project life.

PUBLIC CONSULTATION

Shell has an ongoing, successful public consultation program for the Muskeg River and Jackpine Mine operations. As an extension of this program, Shell will consult with stakeholders about the proposed Pierre River Mine Project, and address concerns to develop a sustainable project.

ENVIRONMENTAL IMPACTS

The combined EIA for the Jackpine Mine Expansion and the new Pierre River Mine concluded that there would be no unacceptable environmental or socio-economic effects from the projects, provided that the proposed mitigation and monitoring are undertaken.

PROJECT BENEFITS

The projects will, over their approximate 40-year life, add an additional 47,700 m^3/cd (300,000 bbl/cd) of bitumen production to Shell's currently approved projects. These new projects will contribute billions of dollars in taxes and royalties to the municipal, provincial and federal governments, which will benefit all Canadians. Long-term benefits to the local community will also be derived from an additional 2,130 full time permanent jobs as a result of the projects. In addition, 28,790 work years of construction employment will be created over 10 years, generating additional tax revenue for all levels of government.

PROJECT BENEFITS (cont'd)

Indirect benefits from the projects will be created by using local suppliers, including First Nations and Métis companies, provided that they are competitive and meet the project and operations requirements.

SCOPE

Shell's applications for EUB and AENV approvals have been integrated to:

- reduce duplication, particularly for project descriptions
- make the review of the application as efficient as possible for regulators and the public

The applications for the Jackpine Mine Expansion and the Pierre River Mine are presented in six volumes:

- Volume 1: Project Description for the Jackpine Mine Expansion, which:
  - provides an overview of the project application
  - describes the existing operations
  - describes the technical basis for the proposed project
  - summarizes the results of the EIA
  - describes the public consultation program
  - contains information required by the EUB to amend the approval under the *Oil Sands Conservation Act*
  - contains information required by AENV to renew and amend the 10-year operating approval under the *Environmental Protection and Enhancement Act* (EPEA), and to renew and amend the approval under the *Water Act*
- Volume 2: Project Description for the Pierre River Mine, which provides similar information to that noted for Volume 1, except that the EUB and AENV approvals sought are new
- the EIA:
  - Volume 3, Air Quality, Noise and Environmental Health
  - Volume 4A, Aquatic Resources
  - Volume 4B, Aquatic Resources Appendices
  - Volume 5, Terrestrial Resources and Human Environment

CROSS-REFERENCES TO REQUIRED INFORMATION

The EUB information requirements and the location of the required information are provided in Table P-1.

Section 19, Alberta Environment Approval Requirements, provides the information and cross-references for the application of the EPEA 10-year operating approval.

For the guide to the location of information required under the EIA Terms of Reference, see EIA Volume 3.

Table P-1: Information for the Application for EUB Approval for the Pierre River Mine

EUB Directive 023	Information Required	Location in this Volume
1.1	Project summary, objectives and approvals requested.	Section 1
1.5.1	Act and section under which the application is made.	Section 1.4 and transmittal letter
1.5.2	Name and address of the applicant.	Section 1.4
1.5.3	Statement of need for, and timing of, the project.	Section 1.1, 13.9 and 14
1.5.4	Scheme description, including the location, size, scope, schedule, pre-construction, start-up, duration and reasons for the proposed schedule.	Section 1.2, 5, 6, 7, 8, 9, 13 and 14
1.5.5	Description of the regional setting with reference to existing and proposed land use.	Section 1.2
1.5.7	Map of existing developments.	Section 1.1
1.5.8	Aerial photo of the proposed development area with locations of project components.	Section 1.1 and 1.2
1.5.9	General description of storage and transportation facilities for diluted bitumen (dilbit), including pipeline size and ownership.	Section 1.2, 2.5 and 6.2
1.5.10	Proposed rate of production of hydrocarbon processed over the project's life.	Section 1.2 and 9.1
1.5.11	Description of oil sands owned or leased.	Section 1.1 and 4.2
1.5.13	Description of proposed energy sources, alternative sources, rates of use and supply sources.	Section 8.2, 8.3, 9.2, 13.6 and 14.3
1.5.14	Results of public information programs.	Section 15
1.5.15	Start and completion dates.	Section 13.9 and 14.1
1.5.16	Name of the person responsible for the application.	Section 1.4
2.1.1	A geological description of the zone or zones of interest in the project area.	Section 3
2.1.2	An evaluation of the reserves within the project area, the mine site, plant site, tailings site, discard site and other surface facilities.	Section 4.2, 5.1 and 5.2
2.1.3	A description of the project layout and mining equipment selected with a map of the land surface topography and project layout.	Section 3.1, 5.5, 5.9, 6.1, 6.2 and 7.1
2.1.4	A description of the mine development plans with a tabulation of the mining volumes and recovery criteria.	Section 5.1, 5.2, 5.3 and 5.5
2.1.5	A description of the design stability analysis of pit slopes and discard.	Section 5.4

Table P-1: Information for the Application for EUB Approval for the Pierre River Mine (cont'd)

EUB Directive 023	Information Required	Location in this Volume
2.4.1	Description of the bitumen extraction process with process flow diagrams indicating major equipment.	Section 6
2.4.2	Overall material and energy balances with respect to hydrocarbon, water use and energy efficiency.	Section 9 and 10.4
2.4.3	The quantity of products, by-products and discard, and a general description of their disposition.	Section 5.5, 5.6, 6.2, 7 and 11
2.4.4	The manner in which surface drainage within the areas of the processing plant, product storage and discard proposal would be treated and disposed of.	Section 10 and 11.2
2.4.5	Comparison of the proposed process with alternative processes considered on the basis of overall recovery, energy efficiency, cost, commercial availability and environmental considerations and reasons for selecting the process.	Section 13
2.5.2	Identification of the source, quantity and quality of any fuels, electricity or steam to be obtained from sources beyond the project site.	Section 8.3 and 8.4
2.6.2	Description of the water management program.	Section 10 and 8.1
2.6.3	Description of the manner in which surface water drainage within the project area would be collected, treated and disposed of.	Section 10
2.6.4	Description of the air and water pollution and monitoring devices.	Section 19
2.6.5	A description of the emission control system.	Section 19
3.1	Commercial viability information.	Section 1.1
3.2	Benefits cost analysis.	Section 18
3.3	Economic Impact.	Section 1.1 and 18
4.0	Environmental Impact Assessment.	Section 17
5.0	Biophysical Impact Assessment.	Section 17
6.0	Social Impact Assessment.	Section 18
7.0	Environmental Protection Plan.	Section 17 (see also EIA)
8.0	Conceptual Development and Reclamation Plan.	Section 20 (see also EIA)
9.0	Solid Waste Management Plan.	Section 11.2

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VOLUME 2: PROJECT DESCRIPTION

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APPLICATION FOR APPROVAL OF THE PIERRE RIVER MINE PROJECT VOLUME 2: PROJECT DESCRIPTION

INTRODUCTION

REQUESTED APPROVAL

Shell Canada Limited (Shell) is applying to the Alberta Energy and Utilities Board (EUB) and Alberta Environment (AENV) for approval to develop a new mining area, the Pierre River Mine. This new development will produce up to 31,800 m^3/cd (200,000 bbl/cd) of bitumen and will include a new mining area and associated processing facilities, utilities and infrastructure.

PIERRE RIVER MINE LOCATION

The Pierre River Mine will be located about 100 km north of Fort McMurray, Alberta (see Figure 1-1) and about 500 km northeast of Edmonton. Fort McKay is the closest community, and is located about 35 km to the south. The project will be generally contained within Townships 97, 98 and 99, and Ranges 10 and 11 W4M.

Access to the new mining area will be via a new road north from the existing Fort Chipewyan winter access road. A new bridge constructed over the Athabasca River will allow for movement of goods and services from the Albian Aerodrome located at the Jackpine Mine. Given the distance from the Pierre River mining area to Fort McMurray, most construction and operations staff will be housed on site and will work a fly-in fly-out operation.

The Pierre River Mine development area is shown in Figure 1-2. An aerial photograph of the area is provided in Figure 1-3.

SCOPE OF REGULATORY SUBMISSION

Shell is making a single regulatory submission, consisting of two applications, to secure approval for future expansion plans. These applications are for:

- an amendment to the Jackpine Mine – Phase 1 approval for an expansion on the east side of the Athabasca River
- a new approval for development of the Pierre River Mine, located on the west side of the Athabasca River

This single submission covers all of Shell's currently defined resources and presents a long-term, comprehensive picture of Shell's development plan for the

SCOPE OF REGULATORY SUBMISSION (cont'd)

area. In support of this submission, a single Environmental Impact Assessment (EIA) has been prepared, which provides the broadest possible scope for assessing the environmental impact from these developments.

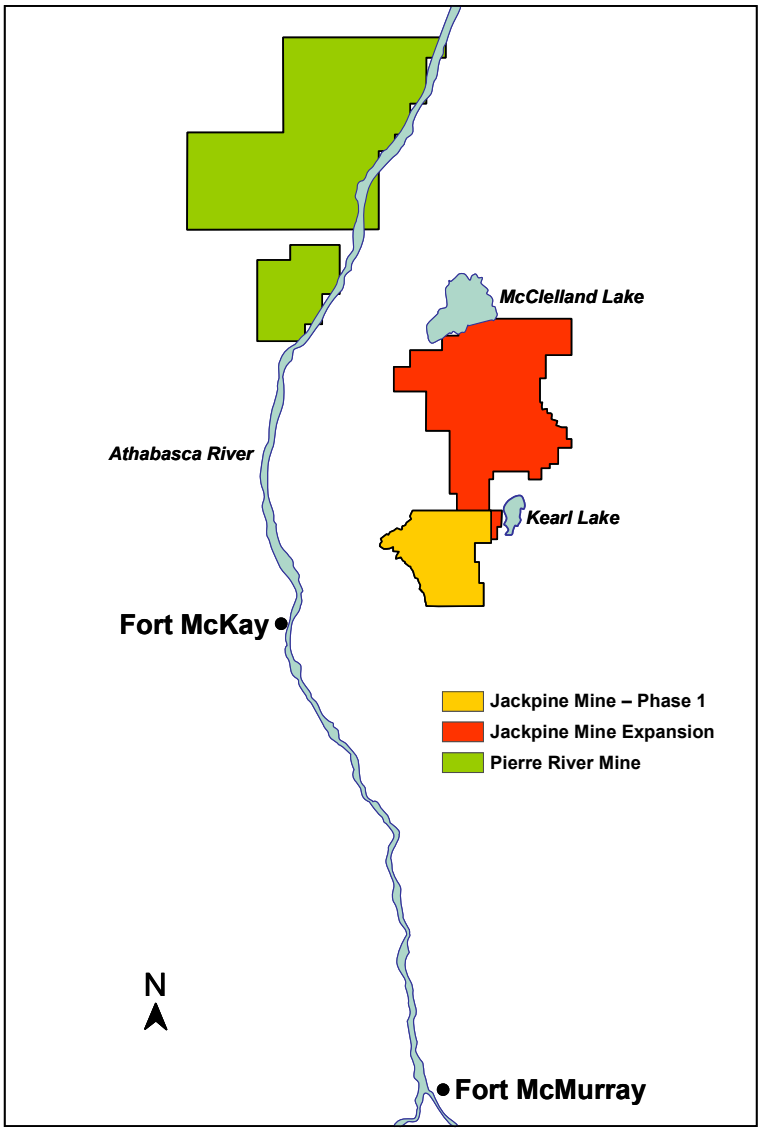


Figure 1-1: Pierre River Mine Location

PROPONENT

Shell Canada Limited (Shell) is the proponent for both the Jackpine Mine Expansion Project and the Pierre River Mine Project applications. Shell will apply for, and hold, all construction and operating regulatory approvals required for the Jackpine Mine Expansion Project and the Pierre River Mine Project on behalf of Shell Canada Energy.

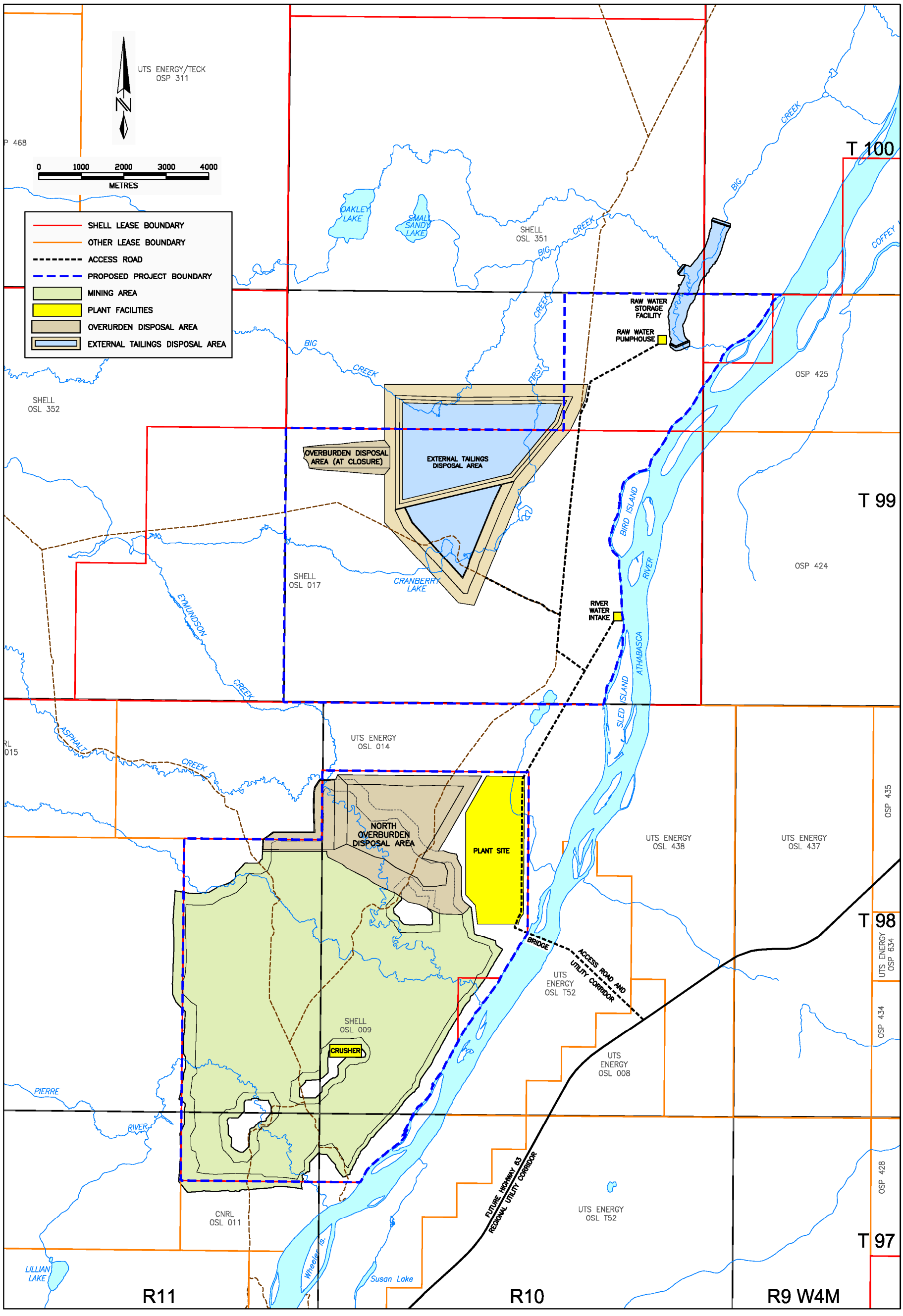


Figure 1-2: Pierre River Mine Development Area

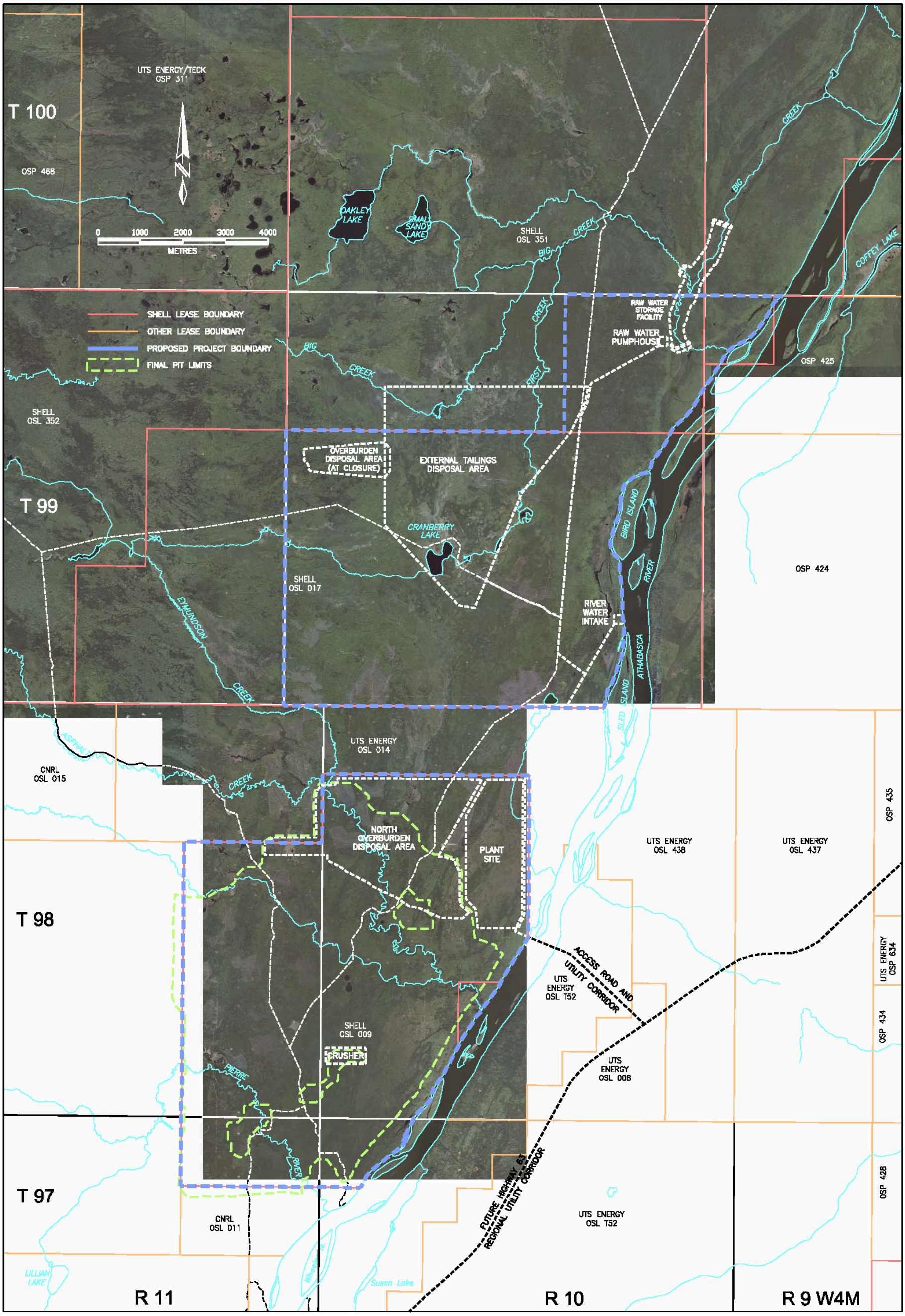


Figure 1-3: Aerial View of Pierre River Mine Development Area

Shell is one of Canada's largest integrated energy companies. Shell is a major producer of natural gas, natural gas liquids, sulphur, bitumen blend and synthetic crude oil products derived from bitumen upgrading. Shell manufactures, distributes and markets refined petroleum products across Canada.

AOSP JOINT VENTURE

The Athabasca Oil Sands Project (AOSP) is a joint venture between:

- Shell Canada Energy (60%)
- Chevron Canada Limited (20%)
- Marathon Oil Sands L.P. (Marathon) (20%)

The AOSP joint venture owns the Muskeg River Mine that has been operational since 2002. The joint venture owners have also elected to participate in the initial development of the Jackpine Mine – Phase 1 now underway.

Albian Sands Energy Inc. (Albian Sands) is a company created by the AOSP joint venture participants to operate the Muskeg River Mine.

DEVELOPMENT CONTEXT

Resource Development Approach

Shell has acquired substantial lease holdings in the Athabasca oil sands region north of Fort McMurray (see Figure 1-4). These lease holdings are located on both the east and west sides of the Athabasca River and are predominately amenable to surface mining. Lease 13 on the east side of the Athabasca River is the current focus for development, with the Muskeg River Mine in production and the Jackpine Mine – Phase 1 under construction.

Shell's plan for its oil sands lease holdings in the Fort McMurray area has been to stage the overall development through a series of expansions. In this manner, the stages can be scaled and executed in a way that balances the pace of development with execution capability and risk. This measured approach provides for the least cost, highest value development of this substantial resource base. It also provides an opportunity to:

- apply the knowledge and efficiencies gained in each stage of development to the next stage
- develop and apply new technologies over time
- spread out environmental and socio-economic effects, which enhances the ability to mitigate any adverse impacts

Final investment decisions will be dependent on future product pricing, construction and operating cost forecasts and the availability of human resources to execute the plans. The nature, stability and impact of federal and provincial fiscal regimes will also be considered.

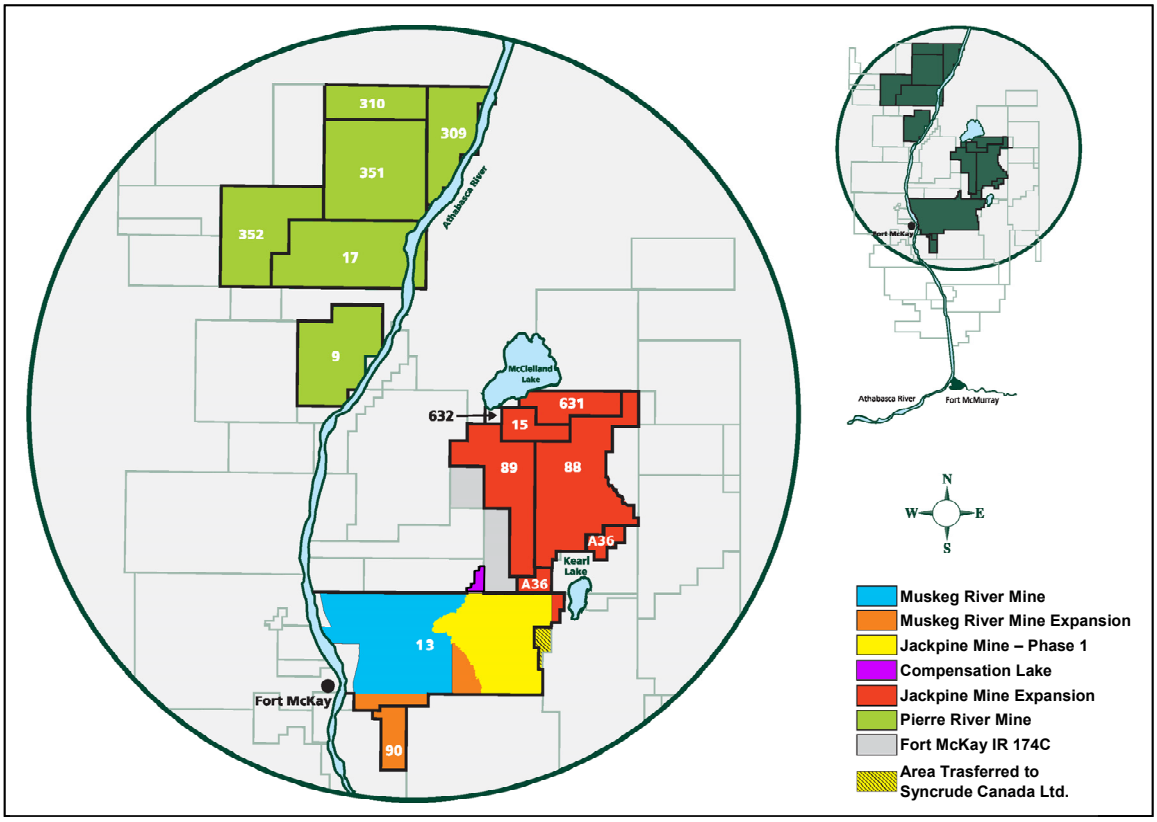


Figure 1-4: Lease Holdings

Regulatory Submission Approach

One consequence of this staged development is that several regulatory approvals have been sought, and granted, for various aspects of the overall development. During this time, Shell has continually assessed its options and incorporated new fiscal, market, environmental and resource information to determine the optimal development approach. After a decade of focused effort, Shell now believes it can provide a more comprehensive and longer-term view of its development plans in the region. This broader picture is consistent with, and responds to, the interests of government and public stakeholders who have all expressed interest in full disclosure of longer-term development plans.

The submission of both the Pierre River Mine and the Jackpine Mine Expansion applications provides this comprehensive, longer-term disclosure of Shell's plans.

CURRENT APPROVED RESOURCE DEVELOPMENT

Muskeg River Mine

The Muskeg River Mine produces a nominal 24,645 m^3/cd (155,000 bbl/cd) of bitumen from Oil Sands Lease 7277080T13 (Lease 13). On June 23, 1999, EUB Approval No. 8512, by Order in Council, granted Shell Canada Limited approval

for this mine. On February 23, 2000, the approval was amended to Approval No. 8512A to transfer the approval to Shell Canada Limited, Chevron Canada Resources Limited and Western Oil Sands L.P. (which has since been acquired by Marathon Oil Sands L.P.), thereby recognizing the AOSP joint venture participants.

Initial production from the Muskeg River Mine began in 2002. Full production levels were achieved in 2004.

Jackpine Mine – Phase 1

On May 31 2002, Shell applied for approval of the Jackpine Mine – Phase 1. Following project review and a public hearing by a Joint Review Panel established by the EUB and the federal government, EUB Approval No. 9756 was granted by Order in Council on February 25, 2004. Approval of the federal government's response to the Joint Review Panel report was granted by Order in Council on April 21, 2004.

The Jackpine Mine – Phase 1 Project application was based on a bitumen production level of 31,800 m^3/cd (200,000 bbl/cd) from three process trains. The current expansion project design is based on three process trains, each of a nominal bitumen production capability of 15,900 m^3/cd (100,000 bbl/cd). Construction of the first process train and its associated facilities is currently underway with start-up scheduled in late 2009 and production ramping up through 2010.

Muskeg River Mine Expansion

With start-up and successful operation of the Muskeg River Mine, the AOSP joint venture participants plan to increase the production capacity of the existing facilities by debottlenecking and adding a third process train with a nominal production capability of 15,900 m^3/cd(100,000 bbl/cd), similar to the current design of the Jackpine Mine – Phase 1. Together with debottlenecking, the overall bitumen production capability of the expanded Muskeg River Mine would be about 43,000 m^3/cd (270,000 bbl/cd).

On April 28, 2005, Albian Sands submitted an application for an amendment to EUB Approval No. 8512 to incorporate the additional Muskeg River Mine facilities required for the expansion. The amendment also included the remaining unincorporated resources from Lease 13 and additional resources from Lease 7280090T30 (Lease 30) and Lease 7280880T90 (Lease 90). Both provincial and federal government agencies carried out a review of the proposed expansion project and a public hearing was held before a Joint Review Panel. Amendment B to EUB Approval No. 8512 was granted for the Muskeg River Mine Expansion Project on April 11, 2007. Federal government approval of the Joint Review Panel report was granted by Order in Council on June 22, 2007.

The Muskeg River Mine Expansion application described options that would integrate the development of the Jackpine Mine – Phase 1 resource with facilities associated with the expansion, mainly froth treatment, with associated utilities and infrastructure. The current project execution plan for the Muskeg River Mine

Muskeg River Mine Expansion (cont'd)

Expansion is following this development option by providing an interconnecting pipeline to enable bitumen froth from Jackpine Mine – Phase 1 to be transported to the expanded Muskeg River Mine froth treatment plant for processing.

CURRENT DEVELOPMENT PLAN

Pierre River Mine Development

In this application, Shell is applying for approval of the Pierre River Mine, a development area located to the west of the Athabasca River. This development will involve mining and processing oil sands in two trains at a combined production rate of 31,800 m^3/cd (200,000 bbl/cd). The mining and process methods will be similar to those used in the Jackpine Mine developments.

Initially, the Pierre River Mine involves developing the oil sands resource contained within Lease 740012009 (Lease 9) with some facilities constructed on Lease 7401100017 (Lease 17). Although outside the scope of this application and environmental impact assessment, future drilling is planned to define the resources contained within the land holdings adjacent to Leases 9 and 17. These include:

- Lease 7405120309 (Lease 309)
- Lease 7405120310 (Lease 310)
- Lease 7405080351 (Lease 351)
- Lease 7405080352 (Lease 352)

If economic oil sand resources are identified within these adjacent land holdings, their development would be the subject of a future regulatory application.

Jackpine Mine Expansion

Shell is also concurrently applying for an amendment to the Jackpine Mine – Phase 1 approval. The proposed expansion has been planned to incorporate oil sand resources in the following Oil Sand Leases:

- Lease 7277080T13 (Lease 13)
- Lease 728101AT36 (Lease AT36)
- Lease 7288080T88 (Lease 88)
- Lease 7288080T89 (Lease 89)
- Lease 7405120015 (Lease 015)
- Lease 7405090631 (Lease 631)

The expansion will increase the production capability of the Jackpine Mine by 15,900 m^3/cd (100,000 bbl/cd) to a total of 47,700 m^3/cd (300,000 bbl/cd) by adding a third process train. The mining development previously approved with the Jackpine Mine –Phase 1 has been modified to allow for a contiguous

development from Lease 13 in a northerly direction to incorporate the leases associated with the expansion.

PROJECT NEED

Shell has made considerable investments in obtaining and defining its lease holdings in the Fort McMurray area. In doing so, it has a responsibility to its shareholder to define and advance the development of these lease holdings in economically viable ways in order to realize value from the investments. Shell businesses, in turn, create value, employment and support for the communities in which they operate.

In addition to its shareholder obligations, Shell has an obligation to the people of Alberta, who own the resource, to develop it in a timely and efficient manner.

To continue to fulfill these responsibilities, approval for development of the leases discussed in this application is required.

The Athabasca oil sands provide a secure, domestic source of crude oil, which can replace diminishing conventional supplies and offset a growing import demand for North America. Since acquiring Lease 13 in 1956, Shell has made a considerable investment in evaluating the oil sands resource potential and in developing the Muskeg River and Jackpine mining areas, along with the associated downstream upgrading projects in Fort Saskatchewan. These investments provide the foundation for further development of Shell's oil sands leases.

The proposed Pierre River Mine development is needed to allow Shell to continue to develop its oil sands assets and to integrate and optimize existing operations. The expansion, integration and optimization will allow for the continued development of these resources in an efficient, economic and environmentally acceptable manner.

PROJECT BENEFITS

The Jackpine Mine Expansion Project and the Pierre River Mine Project (the projects) will, over their approximate 40 year life, add an additional 47,700 m^3/cd (300,000 bbl/cd) of bitumen production to the currently approved projects. These new projects will contribute billions of dollars in taxes and royalties to the municipal, provincial and federal governments, which will benefit all Canadians.

Since the Muskeg River Mine started up in 2002, Albian Sands has paid more than $50 million in taxes to the Regional Municipality of Wood Buffalo. The proposed projects will continue to build on this tax base, contributing substantial economic benefits to the region.

Long-term benefits to the local community will also be derived from an additional 2,130 full time permanent jobs as a result of these projects. In addition,

PROJECT BENEFITS (cont'd)

28,790 work years of construction employment will be created over 10 years, generating additional tax revenue for all levels of government.

Indirect benefits from these projects will be created by using local suppliers, including First Nations and Métis companies, provided that they are competitive and meet the project and operations requirements.

ALTERNATIVES TO THE PROJECT

Shell has investigated alternatives to developing the Pierre River Mine resources and has concluded that the development plan described in this application represents the most practical, economic and sustainable means of extracting the resource. Currently, other methods, such as in situ recovery, are not technically feasible for these leases.

Shell has also considered alternative timing for developing the project, including the option of not developing these leases. Shell needs to develop these leases in an efficient, staged manner to obtain value for both its shareholder and the province. Therefore, the option of not developing these leases does not fulfill the need for the project identified by Shell.

PUBLIC CONSULTATION

Shell strongly supports continued open and honest communication with the public and key stakeholders, and continues to build upon established community relationships. Shell believes that stakeholder dialogue is essential to the development of a sustainable project, and integrates the economic, environmental and social aspects of its developments into its plans.

The Pierre River Mine will continue to build on the foundation already laid down by Shell for its ongoing operations. The consultation program is designed to provide appropriate levels of information to all stakeholders, including information on environmental and social performance, technology and potential benefits associated with the project.

Shell staff participate in a variety of multi-stakeholder forums and meet regularly with representatives of regulatory agencies, neighbouring communities, Aboriginal groups, community organizations, special interest groups, industry and the public. Through this ongoing consultation process, issues and concerns can be resolved and opportunities understood. Shell continues to involve its neighbours in decisions on issues that affect them, with the objective of making sustainable decisions that are viewed as positive over the long term. In particular, a focused effort has been made to work closely with Fort McKay, the community closest to Lease 13, to understand its issues and concerns.

For further information on Shell's public consultation program, see Section 15.

PIERRE RIVER MINE SCOPE

The project involves developing a new mining area and constructing process facilities to produce 31,800 m^3/cd (200,000 bbl/cd) of dry bitumen. The scope includes:

- establishing the Pierre River Mine operations on Lease 9 and additional facility construction activities on other leases, including infrastructure, processing and support facilities
- building site access infrastructure, including a bridge across the Athabasca River, early in the development plan
- constructing ore handling, conditioning, bitumen extraction facilities and a high-temperature froth treatment facility at the Pierre River Mine site
- providing trucks, shovels and crushers
- constructing a new external tailings disposal area at the boundary of Lease 17 and Lease 351 to accommodate the initial volume of tailings produced

MINE DEVELOPMENT PLAN

Figure 1-5 shows the mine plan development sequence for a total integrated 31,800 m^3/cd (200,000 bbl/cd) operation.

The key features of the mine development plan are that it:

- optimizes the extraction plant design by providing higher ore grades in the earlier years which balances ore production during the critical first 10 years of mining
- accommodates the:
  - effective construction of in-pit dykes
  - effective construction of an external tailings disposal area
  - management of space constraints in the overburden disposal area
  - early set-up of an in-pit fluid tailings storage cell
  - effective non-segregating tailings (NST) material placement
- maintains sufficient active mining face lengths to provide space for all mining activities without the mine pit becoming congested with equipment

OPTIMIZATION OPPORTUNITIES

The key optimization opportunities for this development include:

- increasing the combined bitumen recovery by dedicating one processing train to process high-grade ore and the other train to process low-grade ore instead of both trains processing an average feed grade
- reviewing mine plans and technology to determine if crusher moves can be better optimized or eliminated
- incorporating lessons learned through the operation of the Muskeg River Mine and construction and operation of the Jackpine Mine – Phase 1 into the design of the Pierre River Mine facilities

The development plan for these opportunities is to ensure that the concept remains active, and that final evaluation of the alternatives is followed through in the detailed engineering process.

PIERRE RIVER MINE FACILITIES

The Pierre River Mine Project facilities will be located in a single plant site area in the northeastern corner of Lease 9 (see Figure 1-6).

The process facilities will consist of two ore processing trains, and each train will include:

- crushers and conveyors
- slurry conditioning and ore preparation facilities
- extraction facilities
- tailings handling and treatment
- froth treatment
- solvent recovery
- tailings solvent recovery
- asphaltene recovery

The bitumen process line-up is shown in Figure 1-7 and will be identical for each processing train.

Other facilities will include:

- administration buildings
- mine offices
- utilities

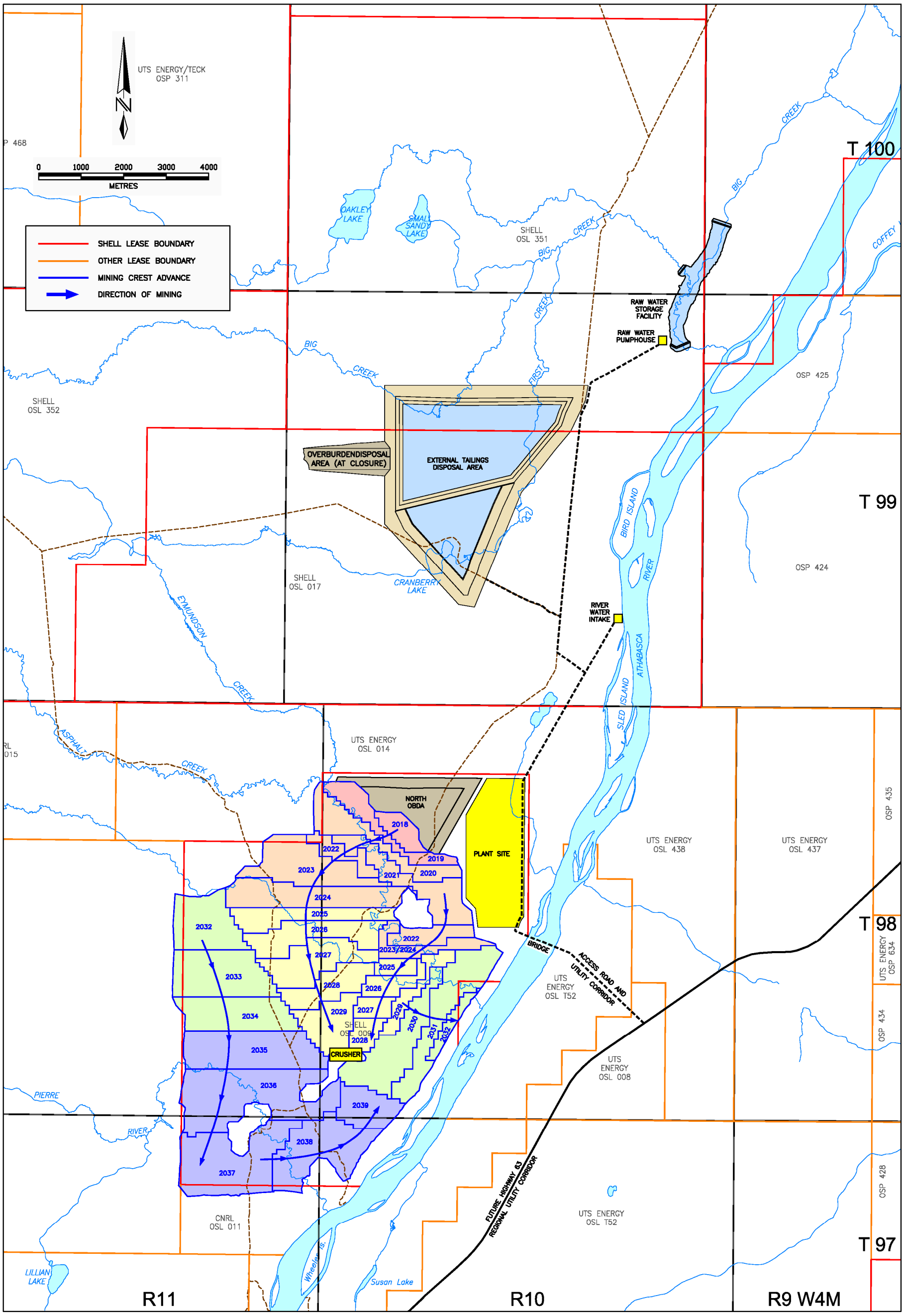
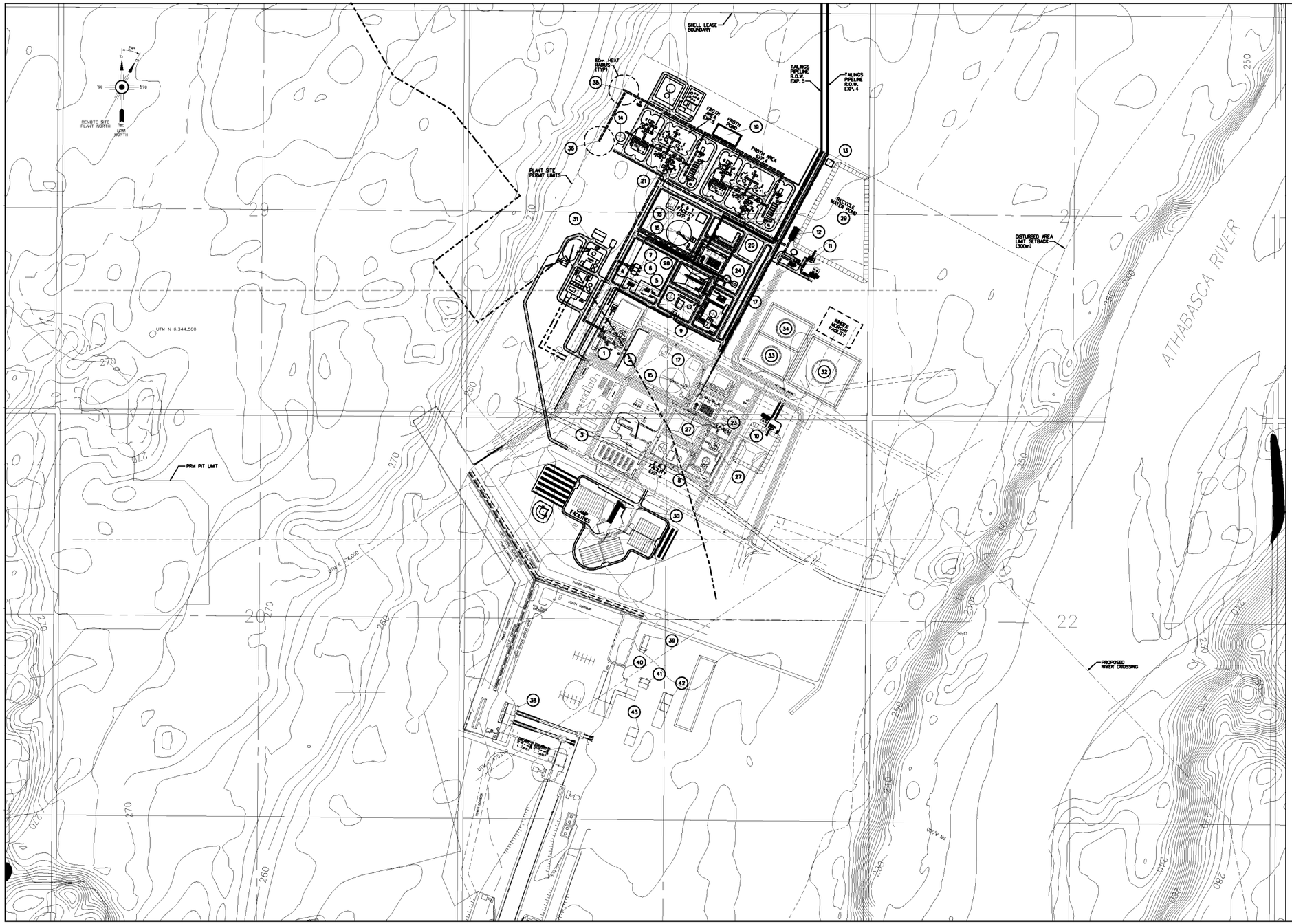


Figure 1-5: Mine Plan Development Sequence



EMISSION SITES

No.	DESCRIPTION	NORTHING	EASTING	ELEVATION
1	COGEN STACK EXP. 4	6376404.222	465979.901	295
2	COGEN STACK EXP. 5	6376383.565	466018.750	295
3	ADMINISTRATION/CONTROL BUILDING	6375998.075	466154.110	260
4	UTILITIES BUILDING EXP. 4 & 5	6376635.392	466095.165	262
5	PACKAGE STEAM BOILER No.1	6376674.887	466107.591	295
6	PACKAGE STEAM BOILER No.2	6376689.015	466115.103	295
7	PACKAGE STEAM BOILER No.3	6376702.259	466122.145	295
8	WARM WATER PUMPHOUSE EXP. 4	6375950.856	466240.963	265
9	WARM WATER PUMPHOUSE EXP. 5	6376565.508	466295.741	265
10	RAW WATER PUMPHOUSE	6376066.233	466635.882	265
11	MAKE-UP WATER PUMPHOUSE	6376734.740	466805.067	265
12	COOLING TOWERS (6)	6376838.957	466733.347	275
13	TAILINGS PUMPHOUSE (TYP. x 5)	6377122.539	466874.600	261
14	FROTH TANK	6377227.764	466040.303	271
15	TAILINGS THICKENERS EXP. 4	6376251.859	466246.088	255
16	TAILINGS THICKENERS EXP. 5	6376842.558	466273.336	255
17	WARMING SHED EXP. 4	6376368.718	466218.425	267
18	WARMING SHED EXP. 5	6376969.407	466273.329	267
19	FROTH POND	6377234.953	466465.541	255
20	SOLVENT RECOVERY UNIT (SRU) EXP. 4	6376933.899	466645.713	285
21	SOLVENT RECOVERY UNIT (SRU) EXP. 5	6377099.638	466334.005	285
22	NOT USED			
23	PRIMARY SEPARATION CELL (PSC) EXP. 4	6376066.439	466437.804	285
24	PRIMARY SEPARATION CELL (PSC) EXP. 5	6376857.138	466465.072	285
25	FROTH SCREENING EXP. 4	6375987.755	466414.126	265
26	FROTH SCREENING EXP. 5	6376576.679	466446.572	265
27	TAILINGS EMERGENCY DUMP POND EXP. 4	6376054.726	466310.563	255
28	TAILINGS EMERGENCY DUMP POND EXP. 5	6376643.566	466336.339	255
29	RECYCLE WATER POND	6376897.771	466913.691	255
30	CAMP FACILITIES	6375741.815	466062.132	259
31	AER BOILER STACK	6376781.857	465945.508	405
32	SOLVENT STORAGE TANK	6376285.614	466854.073	272
33	DILBIT STORAGE TANK EXP. 4	6376350.137	466642.566	272
34	DILBIT STORAGE TANK EXP. 5	6376459.663	466700.705	272
35	FLARE STACK	6377416.203	466053.531	295
36	EMERGENCY FLARE STACK	6377212.186	465954.970	375
37	TAILINGS POND			255
38	BREAKER BUILDING	6374943.159	465634.213	267
39	LIGHT VEHICLE MAINTENANCE SHOP	6375225.339	466159.161	262
40	MINE SERVICES BUILDING	6375097.746	466058.663	267
41	BULK LUBE STORAGE	6375046.777	466156.953	260
42	WARMING SHED / COLD STORAGE	6374986.691	466250.187	255
43	TIRE SHOP	6374851.409	466114.324	255

NOTES:

1. MEAN SITE ELEVATION ASSUMED TO BE 255m.
2. COORDINATES SHOWN ARE UTM NORTHING AND EASTING VALUES IN METRES.

Figure 1-6: Pierre River Mine Site Plan

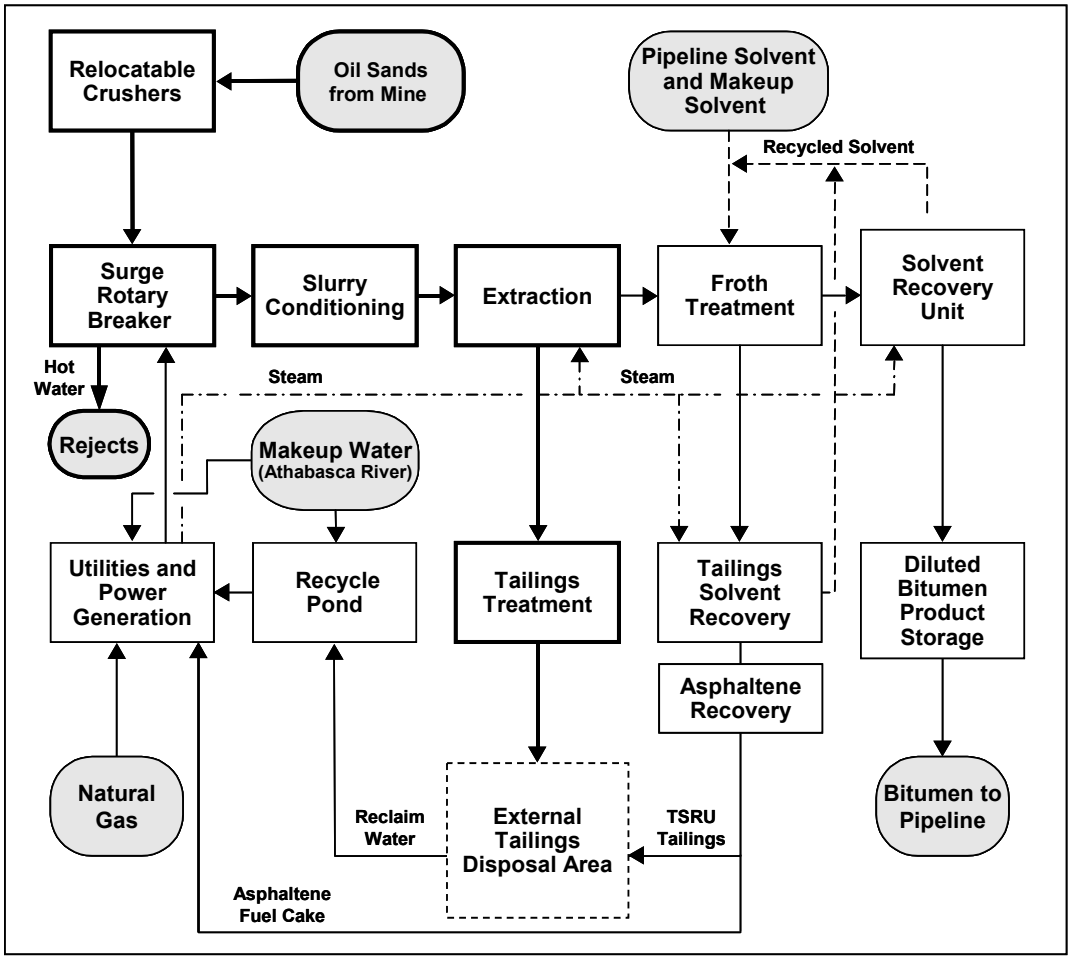


Figure 1-7: Bitumen Processing

Crushers and Conveyors

A high-capacity ore feed and size reduction system that matches a large-scale truck-and-shovel mining operation will be provided. The ore feed system will comprise two relocatable double-roll crushing plants. The crushing plants will reduce the size of the mined oil sands to less than 400 mm for transportation by conveyor to a surge bin.

Slurry Conditioning and Ore Preparation Facilities

The slurry conditioning and ore preparation facilities will include rotary breakers and pipeline conditioning. Two rotary breakers will size the ore to less than 51 mm while mixing it with warm water to create a slurry.

This slurry will be pumped 3 km in a conditioning pipeline, which will transform the material into an aerated, uniform-density slurry that is ready for bitumen separation from the sand.

Extraction Facilities

From the slurry conditioning pipeline, the oil sands will be delivered to a primary separation cell (PSC), where the bitumen will be separated and discharged from the cell in the form of froth. The bitumen froth will be deaerated, screened to remove debris and pumped to a froth storage tank. This tank will provide surge capacity between the extraction and froth treatment. Additional bitumen will be recovered from a middlings stream pulled from the PSC in primary flotation cells. Coarse tailings from the PSC will be pumped to the tailings processing plant.

Tailings Handling and Treatment

In the tailings processing plant, coarse particles will be removed from the slurry stream, using a vibrating banana screen. Oversize material will be sent to the coarse tailings line. Screen undersize will be pumped to secondary flotation, where residual bitumen will be recovered. Secondary flotation tailings will be pumped to a cyclone where fines and a significant portion of the water in the cyclone overflow will be sent to the tailings thickeners. Water and heat will be recovered in the thickener overflow. Thickened tailings (TT) will be pumped to the external tailings disposal area (ETDA). Underflow from the cyclone will flow, by gravity, to the coarse tailings pump box and be pumped to the ETDA, where it will be used for dyke construction.

Froth Treatment

The Pierre River Mine froth treatment design will be based on the same high temperature froth treatment (HTFT) process that is currently being constructed at the Muskeg River Mine plant site to support the Jackpine Mine – Phase 1 extraction operations. Asphaltenes will be precipitated by adding a paraffinic solvent to the froth to reject the solids and water in the froth. The HTFT process will start with the froth storage tanks, extend through two stages of counter-current froth cleaning, and end with the final solvent-rich diluted bitumen product and low solvent content tailings stream.

Solvent Recovery

Solvent will be recovered to a diluted bitumen specification of 32 vol% in the dilbit product. The level of solvent in the dilbit product is required to meet the diluted bitumen pipeline specification and allow for efficient pipeline transportation.

Tailings Solvent Recovery

The tailings solvent recovery unit (TSRU) will treat the underflow tailings stream from the second-stage settler in the HTFT train. The TSRU will consist of two stages of separation, with the second stage operating under vacuum. The tailings discharge stream from the second-stage column is designed to contain less than four volumes of solvent per 1,000 volumes of bitumen produced annually.

Asphaltene Recovery

Asphaltenes, water, mineral solids and solvent in the TSRU stream will be separated in the asphaltene recovery process. The process will consist of the following units:

- gravity separation
- asphaltene dewatering
- tailings thickening and water recovery
- solvent recovery unit

UTILITIES

The utilities required for the Pierre River Mine include:

- water
- cogeneration
- auxiliary steam
- boiler feedwater treatment
- electrical power
- instrument air
- natural gas
- potable water
- sewage treatment

Water

Water will be required:

- for process operations
- for gland water
- for storage requirements
- as compensation for seasonal fluctuations

Generally, water will be supplied from:

- the Athabasca River
- connate water contained within the oil sand
- tailings reclaim water
- groundwater obtained from dewatering the basal aquifer
- surface runoff

To reduce the use of river water in accordance with Alberta Environment and Fisheries and Oceans Canada's *Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River*, February 2007, water will be stored in raw water storage facilities capable of sustaining plant operation for up to 30 days.

Fuel Source

A number of cogeneration options are being considered for providing the main source of steam and electricity at the Pierre River Mine. The options include:

- an asphaltene energy recovery (AER) unit with conventional boiler technology
- a natural-gas-fired cogeneration facility

The AER technology is of interest because it makes use of an otherwise waste stream as a source of energy, thereby reducing overall dependence on natural gas as a source of energy for the proposed project. Shell is evaluating further improvements to this technology, such as oxygen firing, that could reduce the overall emissions to the equivalent of gasification with future carbon capture-ready option.

Cogeneration

Power and steam will be generated by a cogeneration facility. Waste heat from a gas turbine will be fed to a heat recovery steam generator (HRSG). Auxiliary firing of natural gas in a duct burner upstream of the HRSG will supplement the heat available for steam generation. The gas turbine will normally provide the site power requirements. Any excess power will be exported to the grid, and any deficit will be imported.

Auxiliary Steam

Additional steam required beyond that produced by the HRSG will be provided by two gas-fired packaged auxiliary boilers.

Boiler Feedwater Treatment

A new water treatment plant at the site will supply softened boiler makeup water to the cogeneration plant. The makeup water is required to replace steam condensate lost in the TSRU and continuous boiler blowdown. The plant inlet feed will be water from the raw water pond.

Electrical Power Distribution

A substation will be located in the utilities area to provide power to the cogeneration plant and associated utility loads. An emergency generator will be provided to supply electrical power to critical loads during power outages.

Compressed Air

Two compressed air systems will be provided, one for extraction and one for froth treatment. Both compressed air systems will provide instrument and utility air.

INFRASTRUCTURE

Integration with Existing Facilities

The Pierre River Mine operations will use the infrastructure built to support the Muskeg River and Jackpine Mine area operations, including:

- the airstrip
- camp accommodations
- reusable and mobile construction facilities

New Infrastructure Required

No facilities currently exist at the Pierre River Mine area. All common systems will need to be constructed to service the initial operations including:

- ponds for:
    - raw water
    - fire water
    - stormwater
    - potentially oily water
    - effluent
- raw water treatment
- wastewater treatment, sewage and waste storage systems
- an air compression system
- power distribution, main substations and an emergency generator
- a cooling water (distribution, single tower and main basin) system
- a control room
- flushing oil and slop oil systems
- undergrounds and sewers
- feed and product shipping (including custody transfer meters)
- natural gas supply
- an instrument and utility air system
- a flare system
- a nitrogen system
- interconnecting pipe racks
- new buildings

Any future growth of operations at the Pierre River Mine will build upon the already established infrastructure.

SCOPE

This subsection:

- outlines the principles that will be used to manage the environmental and socio-economic aspects of the Pierre River Mine
- identifies the key environmental and socio-economic issues associated with the development

PRINCIPLES

The principles outlined in this application and the EIA will be the basis for managing the environmental and socio-economic aspects of the Pierre River Mine. Generally, the Pierre River Mine will be developed based on Shell's:

- Health, Safety and Environmental Policy (see Section 12.1)
- Commitment to Sustainable Development (see Section 12.1)

ENVIRONMENTAL MANAGEMENT PREREQUISITES

Effective environmental management requires:

- a comprehensive understanding of baseline environmental conditions, within, and adjacent to, the proposed development areas
- a good understanding of potential environmental effects, validated by the:
    - relevant construction and operating experience at the Muskeg River Mine, the Jackpine Mine – Phase 1 and other oil sands operations in the region
    - results of site-specific and regional environmental monitoring and research programs

The Pierre River Mine is being developed in a region of the province where a significant level of scientific baseline and impact assessment knowledge is available. Since commercial development of the oil sands began in 1967, numerous scientific and environmental impact assessments, monitoring and

ENVIRONMENTAL MANAGEMENT PREREQUISITES (cont'd)

research programs have been, and continue to be, conducted in the surface mineable oil sands area.

Environmental Impact Assessment

A combined Environmental Impact Assessment (EIA) has been prepared for the Pierre River Mine Project and the Jackpine Mine Expansion Project (the projects). The EIA concluded that there would be no unacceptable environmental or socio-economic effects from the projects, provided that the proposed mitigation and monitoring is undertaken.

Key Environmental Issues

The key environmental issues arising from the projects are similar to those currently being managed by the existing operators and communities. The issues identified through consultation with stakeholders and regulators are the:

- effects on water quality and flows and aquatic ecosystems in the Pierre River area
- sustainability of the Pierre River area watershed
- effects on air quality, and subsequently, on aquatic and terrestrial receptors
- ability to reclaim disturbed landscapes to viable terrestrial and aquatic ecosystems
- loss of traditional land use
- effects on wildlife populations and movement corridors
- effects on the health of residents located near the projects

Key Socio-Economic Issues

The key socio-economic issues identified through consultation with stakeholders in the Regional Municipality of Wood Buffalo are:

- access to training, business, investment and employment opportunities for local residents
- the cumulative effects on infrastructure and community services in the Regional Municipality of Wood Buffalo, including:
  - access to affordable housing
  - access to a range of social services
  - traffic management
- the retention of traditional and current Aboriginal culture

COLLABORATIVE ENVIRONMENTAL INITIATIVES

Shell is involved in a number of collaborative environmental initiatives, including:

- actively supporting regional multi-stakeholder committees to develop and implement regional environmental monitoring programs for air and aquatic resources, regional environmental management systems and research, including supporting such groups as the:
  - Wood Buffalo Environmental Association (WBEA)
  - Regional Aquatic Monitoring Program (RAMP)
  - Cumulative Effects Management Association (CEMA)
- gathering environmental information through industry collaborative research programs through the Canadian Oil Sands Network for Research and Development (CONRAD) and CEMA

SCOPE

Shell, as the project proponent, will apply for, and hold, all construction and operating regulatory approvals. This subsection identifies the primary approvals from the EUB and AENV required for constructing and operating the Pierre River Mine facilities, as well as the relevant legislation. The primary federal approvals that are required to construct and operate the new mining development are also identified.

PRIMARY APPROVALS REQUESTED

Table 1-1 summarizes the primary approvals requested for the Pierre River Mine Project.

Table 1-1: Primary Approvals and Amendments Requested for the Pierre River Mine

Approval	Legislation	Nature of Approval	Approval Authority	Date Needed
Scheme for recovering oil sands and production of oil sands products	*Oil Sands Conservation Act* (OSCA)	New	EUB	2010
EPEA 10-year operating approval	EPEA	New	AENV	2010
Diversion, control and use of water and construction, operation and maintenance of related structures	*Water Act*	New	AENV	2010

Approvals Requested Under OSCA

The approvals requested in this integrated application cover:

- the project area, incorporating all lands contained within:
  - Lease 740012009 (Lease 09)
  - Lease 7401100017 (Lease 17)
- a processing scheme to recover oil sands

Approvals Requested Under EPEA

A 10-year operating approval is requested in this application to cover:

- development, operations and reclamation of the Pierre River Mine
- construction and operation of:
    - an oil-sands plant and utilities
    - a hazardous waste storage facility
    - wastewater and stormwater systems
    - bulk petroleum storage facilities
    - a water supply, treatment and distribution system

Approvals Under the Water Act

Water approval and the associated licence is requested under the *Water Act*, to cover:

- the delineation of the area boundaries identified in the application to incorporate the Pierre River Mine and its associated facilities
- water withdrawals from the Athabasca River
- the diversion of surface water from the project area
- all activities related to the *Water Act* that will allow the licensee to carry out the activities granted under an EPEA approval

ANCILLARY APPROVALS REQUESTED

Ancillary approvals are requested from:

- AENV for the detailed design of the tailings impoundment structures
- Alberta Sustainable Resource Development (ASRD) under the *Public Lands Act,* for a Mineral Surface Lease to incorporate the area covered by an EPEA approval

Shell will require other municipal, provincial and federal approvals for the Pierre River Mine (see Table 1-2). These approvals will be the subject of independent applications by Shell.

COMPLIANCE WITH GOVERNMENT POLICIES AND PLANS

The Pierre River Mine will be constructed and operated in accordance with applicable acts, regulations and approvals granted. Shell supports the Government of Alberta's policy to encourage development of the oil sand resources of northeastern Alberta in a sustainable and environmentally responsible manner. The Pierre River Mine conforms to Land Use Order

M06555-93 for the Regional Municipality of Wood Buffalo, which allows oil sands development as a discretionary use in the rural district in which Leases 9 and 17 are located.

Table 1-2: Other Approvals Required for the Pierre River Mine

Approval	Legislation	Approval Authority
Development permit	*Municipal Government Act*, Part 17	Regional Municipality of Wood Buffalo
River crossings (bridges and utilities)	*Navigable Waters Protection Act*	Transport Canada – Coast Guard
Fish habitat harmful alteration, disruption or destruction	*Fisheries Act*	Fisheries and Oceans Canada
Historical resources clearance	*Historical Resources Act*	Alberta Tourism, Parks, Recreation and Culture

COMMUNICATION WITH THE APPLICANT

All communication with Shell on these regulatory applications should be directed to both:

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**APPLICATION FOR APPROVAL OF THE
PIERRE RIVER MINE PROJECT
VOLUME 2: PROJECT DESCRIPTION**

SCOPE

This section outlines the ongoing operations at the Muskeg River Mine Project. Because the base Muskeg River Mine is the only mine currently operating, the description focuses on those facilities and the production achieved. The Jackpine Mine – Phase 1 is being constructed and is scheduled to start up by 2010. The mine and extraction facilities will be located on the east side of Lease 13, in the Jackpine Mine development area, and the froth treatment plant will be located adjacent to the current Muskeg River Mine froth treatment plant on the western part of Lease 13.

The operating and construction experience at the Muskeg River Mine has been the basis for much of the design and planning work completed to date and will continue to positively influence Shell's future design work, including that of the Pierre River Mine.

MUSKEG RIVER MINE ACHIEVEMENTS

The Muskeg River Mine Project received regulatory approval in 1999. The mine was constructed between 1999 and 2002, and was started up in late 2002. The Muskeg River Mine was designed and built with the benefit of a significant knowledge base established within the oil sands industry over the previous 30 years of oil sands development.

Successes for the Muskeg River Mine Project include:

- constructing a major mining facility with world-class safety records
- developing a large-scale mine that uses the latest process equipment and environmental process monitoring technology
- commercializing technologies in extraction and paraffinic froth treatment
- providing work for more than 1,000 permanent employees

The design and future construction of the Jackpine Mine Expansion and the Pierre River Mine will build from these accomplishments and provide a knowledge base for continued positive development.

PRODUCTION PROFILE

Bitumen production at the Muskeg River Mine began in late 2002. After initial start-up and early operational challenges, the mine's production steadily increased through to Q2 2004, when calendar-month production met design targets. Since then, production has consistently averaged at or exceeded design targets. This sustained production level also takes into account a scheduled turnaround in 2006 and normal, ongoing maintenance activities.

MAJOR FACILITIES

The existing major facilities at the Muskeg River Mine are:

- a truck-and-shovel mining operation
- a crusher and conveying system
- a material sizing and conditioning system
- an extraction plant
- an external tailings disposal area
- a froth treatment plant

A simplified process flow diagram is shown in Figure 2-1. Shell expects to use a similar process and facilities for the Pierre River Mine.

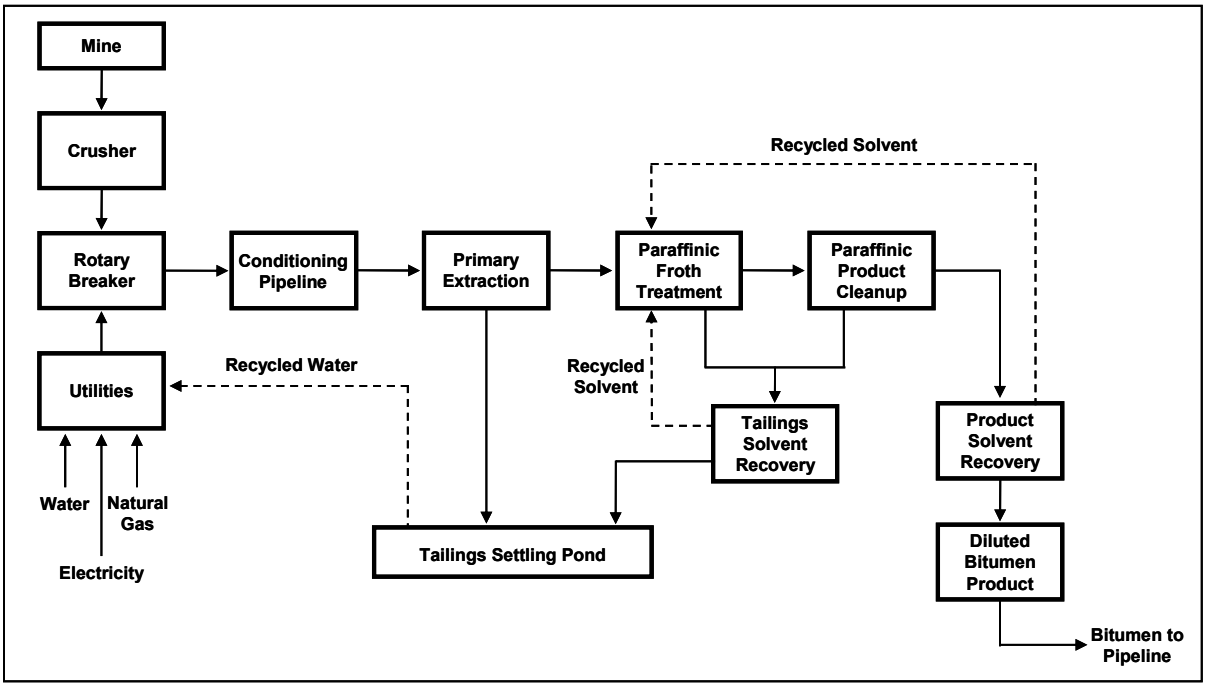


Figure 2-1: Simplified Process Flow of the Existing Muskeg River Mine Facilities

Truck-and-Shovel Mining Operation

The existing truck-and-shovel mining operation uses:

Truck-and-Shovel Mining Operation (cont'd)

- about thirty 363-t trucks
- five 55 m^3-class electric cable shovels
- two smaller hydraulic shovels

Additional equipment, including hydraulic excavators, and 240 t, 150 t and 90 t trucks, is provided by various earthmoving general contractors.

Crusher and Conveying System

The crusher and conveying system sizes and transports material to the processing facility. Two double-roll crushers, rated at 14,000 t/h, load material onto a single surge conveyor.

Material Sizing and Conditioning System

The material sizing and conditioning system further reduces material to less than 5 cm and conditions and transports the slurry to the extraction plant. The system consists of an ore silo with a live surge capacity of 10,000 t. Feed is transferred to three rotary breakers from the ore silo at about 7,000 t/h. Heated water is added and the slurry is transported through a 2 km conditioning pipeline to the extraction plant.

Extraction Plant

The extraction plant uses warm water extraction technology. The primary components of the extraction plant are two trains with 23-m diameter primary settling vessels (PSVs) with primary and secondary flotation cells. Bitumen froth from the PSVs is deaerated, screened and stored in two froth storage tanks. The tailings are processed through secondary flotation for final bitumen cleaning.

External Tailings Disposal Area

Secondary flotation is followed by cyclone classification that separates the coarse solids from the whole tailings. The coarse sand is transferred to the external tailings disposal area (ETDA) where it is used for internal beaches and dyke construction. The fine solids in the cyclone overflow are sent to two 90-m-diameter thickeners, where warm water is recovered and returned to extraction for use as dilution water. The fines are concentrated and pumped to a designated portion of the ETDA for storage.

Froth Treatment Plant

The froth treatment plant consists of two counter-current decantation (CCD) trains operating at atmospheric conditions. Bitumen froth from the froth storage tanks is mixed at an approximate solvent to bitumen ratio of about 2:1 to form the feed to the CCD unit. The clean bitumen product is produced as an overflow from the first stage of the CCD unit. This overflow is passed through a solvent recovery unit to reduce the product solvent concentration to about 0.3:1 on a volume basis. Recovered solvent is cooled and returned to the froth treatment

process. The produced diluted bitumen is transported to the Scotford Upgrader in Fort Saskatchewan, where the solvent is recovered and returned to the Muskeg River Mine for reuse in the froth treatment CCD unit.

Tailings containing solvent from the CCD units are transferred to a common tailings solvent recovery unit (TSRU). This stream is heated by direct steam injection and the solvent is recovered, cooled and returned to the froth treatment CCD unit. Tailings (a mixture of mainly water, solids and asphaltenes) are pumped to the ETDA for final storage.

FACILITY PERFORMANCE

Mining

Since 2002, the performance of the truck-and-shovel operation has met expectations. Although contract equipment was used during start-up and commissioning, owner equipment now handles all primary material movements for the Muskeg River Mine operation. Contracted equipment is primarily used for rejects handling, reclamation and civil support. Daily material movement currently averages about 370,000 t.

Crushing and Conveying

The Muskeg River Mine crushers have exceeded design capacity during summer conditions. However, work is underway to more fully realize design capacity during severe winter conditions.

The availability and capacity of the surge conveyor have met design expectations.

Sizing and Conditioning

Material flow characteristics in the silo and reclaim conveyors initially resulted in either reduced material flow rates or blockages from compacted material. Air and heat have been added to improve flow characteristics over a wider operating range. Generally, the system has functioned within acceptable design parameters.

Rotary breakers have successfully processed material at design tonnage rates, with wear within expected parameters. Reject rates have been stable and within design limits, averaging below 4% per annum on a dry-feed basis.

Extraction Plant

The Muskeg River Mine extraction plant achieves throughput rates, product quality and recovery that support the annual production targets. The process will be further optimized to sustain performance at design rates over a broad range of ore grades. A key focus continues to be identifying and resolving mechanical reliability and operating control strategies.

Extraction Plant (cont'd)

Bitumen recovery has exceeded regulatory guidelines at higher grades. Recovery improvements for low-quality ores are being sought through a number of initiatives, which are being reviewed with the EUB.

The froth deaerator and froth screening units have operated at, or above, design capacity. Modifications in the froth screening area have improved operational flexibility and reliability.

Froth Treatment

A key feature of the paraffinic froth treatment process is the production of a clean bitumen that meets or exceeds pipeline quality specifications for transportation.

Both production and product quality targets, based on the initial paraffinic froth treatment technology development work, have been achieved. Rates in excess of 31,800 m^3/sd (200,000 bbl/sd) of bitumen product have been attained, while sustaining quality specifications and recovery.

Solvent losses have been reduced from 8.9 solvent units lost for each 1,000 units solvent used (vol/1,000 vol) in 2004 to 4.0 vol/1,000 vol in 2007. Higher than expected solvent concentrations in the feed to the TSRU unit had resulted in a variety of operational and mechanical reliability challenges. Through modifications and improvements to the design of the TSRU, solvent recovery is achieving target rates. These modifications have been, and will continue to be, incorporated into the design parameters for all future operations, including the Pierre River Mine. Ongoing work in this unit is regularly reported to the EUB.

EXTERNAL TAILINGS DISPOSAL AREA

The current tailings management system at the Muskeg River Mine involves ongoing construction of an above-grade ETDA using tailings sand as the competent containment construction material. Water, fine mineral solids and the balance of sand not used in constructing the ring dykes of a pond are stored in the beaches and basin of the ETDA. Sand is also stored on the flanks of the ETDA in areas designated as toe berms, and will be stored in the ETDA south extension area (SEA), which is currently being commissioned. After partial clarification, water is drawn from the pond and reused in plant operations, especially extraction operations. Water collected from precipitation and from depressurization wells is directed to the ETDA basin as part of an overall water management program.

TAILINGS STREAMS

In addition to producing water, tailings operations currently manage the following three basic tailings streams at the Muskeg River Mine ETDA:

- cyclone underflow tailings (CUT)
- thickened tailings (TT)
- tailings solvent recovery unit (TSRU) tailings

The TSRU tailings are delivered to the ETDA from the froth treatment plant. The CUT and TT streams are delivered from the bitumen extraction facilities. The extraction tailings exit from the secondary flotation cell as whole tailings. The whole tailings are cycloned to produce an overflow stream and an underflow stream. The overflow stream is sent to the tailings thickeners and the underflow stream is mixed with process-affected water to produce CUT before being transported to the ETDA. The thickener produces thickener overflow and thickener underflow. The overflow comprises a warm water recycle stream that is reused in bitumen recovery, and the thickener underflow comprises the TT stream.

During the summer, the CUT sands are discharged into cells and compacted to form the more solid internal core of the ETDA, and water and uncaptured mineral solids are decanted from these cells. Additional CUT that is required for the internal core is deposited without compaction to form loose, water-saturated sandy beaches. The TT and TSRU tailings are discharged into cells and are not currently suitable to be used as construction materials. When deposited at the

TAILINGS STREAMS (cont'd)

ETDA, each of these streams produces water-saturated solid deposits and runoff that contains suspended fine solids that are routed to the ETDA pond. Relatively mineral-solids-free water is released from the tailings deposits through consolidation processes. The runoff and consolidation water streams commingle to produce another tailings product, which is a suspension of fine mineral solids and water that settles slowly to produce process-affected water and thin fine tailings (TFT). The recovery and reuse of the process-affected water is essential to support plant operations and on-site water inventory management.

MATURE FINE TAILINGS

With time, the density of the TFT increases until the gravimetric ratio of fines to fines plus water is in excess of 35 wt%, at which time the material is deemed to have formed mature fine tailings (MFT).

THIN FINE TAILINGS

The quantity of thin fine tailings from each of the tailings streams is typically inversely proportional to the water content of the slurry delivered, and proportional to the relative amount of coarse mineral solids (sand-sized particles) to fine mineral solids (silt and clay-sized particles).

FLUID FINE TAILINGS

The coarse sand fraction provides the bulk of the above-grade containment, whereas the settling pond portion of the ETDA functions as a water clarifier and interim settlement and storage area for FFT. A clear water zone cap at least 3 m thick is maintained on the pond surface to:

- provide recycle water of suitable quality for plant processing
- help manage volatile organic compound (VOC) emissions from TSRU tailings

Water is lost to evaporation and to storage in pores in the tailings deposits. Some water is released from the deposits after initial settling and subsequent tailings consolidation.

OPTIMIZING UTILITIES

Energy management is a key sustainable development objective. The key focus to meeting this objective includes:

- targeting reduced energy demand
- optimizing utilities

Cogeneration Facility

The existing Muskeg River Mine project includes a highly efficient cogeneration facility with two 80 MW gas turbine generators, each with a heat recovery steam generator (HRSG) and duct firing to maximize efficiency. This facility is owned and operated by ATCO Power Canada Ltd. All the heat and about half of the electrical power generated by this facility is consumed by the Muskeg River Mine. Any additional electrical power generated is transferred into the regional power grid.

Heat Recovery

Initial heat integration and recovery expectations have not been met because of a number of process factors. Temporary boilers have been installed to increase steam capacity by about 100 t/h in winter, and the overall process heating system has been optimized by such measures as a closed loop cooling water system, which was installed in 2007.

Energy Efficiency Programs

Energy efficiency programs to enhance process and heat integration include:

- recovering solvent vapour and natural gas from froth treatment and directing them to the cogeneration facility for steam generation

- installing a closed-loop heating and cooling system for the solvent recovery unit and process water interface to reduce exchanger fouling and water system corrosion

AUXILIARY SYSTEMS

Process water has been provided by combining:

AUXILIARY SYSTEMS (cont'd)

- muskeg surface drainage
- basal aquifer depressurization
- reclaimed water from the tailings pond
- raw makeup water from the Athabasca River

Currently, excess water is available in the ETDA and about 11,000 m^3/h is being reclaimed from the tailings settling pond for reuse in the process. The objective is to maximize the use of reclaim water to reduce the volume of makeup water withdrawn from the Athabasca River.

Nitrogen and instrument and utility air are supplied by conventional industrial units on site.

DIESEL FUEL

Between 50 and 80 ML of diesel fuel is required annually for the Muskeg River Mine operations, depending upon the mine stripping ratio and the haulage distances. Diesel consumption increases as strip ratios and haulage lengths increase.

INFRASTRUCTURE

The on-site, Class III industrial landfill continues to be used for solid waste disposal.

A hazardous waste storage area has been developed to provide interim storage for waste that is unsuitable for the Class III landfill. This storage area is operated according to the *Environmental Protection and Enhancement Act* (EPEA) Waste Control Regulation standards, and is fully secured with controlled access.

The initial construction camp has been demobilized. A new 2,500-bed construction camp was built in 2007 to accommodate construction workers for the expansion project that is currently under construction. This is a key feature of Shell's efforts to minimize the adverse socio-economic impacts of its regional developments. This camp will also be used for any potential future construction projects.

PURPOSE

Shell's objective is to fully develop its contiguous mineable lease holdings on the western side of the Athabasca River, and eventually achieve a daily production level of about 31,800 m^3/cd (200,000 bbl/cd). Approval of the Pierre River Mine application will provide the basis for developing these leases.

For the Pierre River Mine, the plan is to stage the development in about two 15,900 m^3/cd (100,000 bbl/cd) facility blocks, versus implementing a single 31,800 m^3/cd (200,000 bbl/cd) facility at one time. This phased approach will allow better project management control, with a smaller scope that could lend itself to:

- different contracting strategies
- a smaller craft labour peak
- an opportunity to distribute resources over a longer period, to provide sustained employment and contracting opportunities

Additionally, the development plans are scheduled subsequent to the Jackpine Mine expansions, to provide the potential to maintain resource levelling and craft labour peaks.

UTILITY CORRIDORS

New utility corridors will be required as part of the Pierre River Mine to transport natural gas, power, dilbit and diluent. These corridors will not be included as part of the project, with the current assumption that they will be owned by a third party through either existing or new commercial arrangements.

ACCESS

Access to the Pierre River Mine will be provided by a 4 to 5 km road linking Lease 9 to the Regional Municipality of Wood Buffalo's Fort Chipewyan winter road, which is about 16 km north of the end of Highway 63. This will require the construction of a bridge over the Athabasca River.

INTEGRATION AND SUPPORT

The Pierre River Mine will be supported:

- during construction and operations by the approved Shell aerodrome facility in the Sharkbite area of Lease 13

- during construction and operations, including turnarounds, by a 2,500-person camp located on or near Lease 9. Any additional required workforce will be housed in other local third-party camps.

PURPOSE

Comprehensive health, safety and environment (HSE) management systems were developed and implemented as a prerequisite to commissioning and starting up the existing Muskeg River Mine. These systems are currently in place and are maintained to meet the requirements of the current operation. They will be expanded and similarly applied at the Pierre River Mine.

The HSE-SD systems for the Jackpine Mine Expansion and the Pierre River Mine will follow a structure similar to that developed at the Muskeg River Mine. Adjustment will be made for any materials, conditions, equipment or operating environments unique to each operating area.

HSE PROGRAM RESULTS

The Muskeg River Mine operation has achieved numerous safety milestones and has been recognized with many regional and provincial safety awards. The safety successes achieved at the Muskeg River Mine, along with the lessons learned from accident investigations and near-miss analyses, are integral to the ongoing continuous improvement of safety systems at both current and future operations, including the Pierre River Mine.

SUSTAINABLE DEVELOPMENT AND HSE POLICIES

The foundation for the Muskeg River Mine HSE management systems are Shell's:

- Commitment to Sustainable Development Policy
- Health, Safety and Environment Policy

This commitment entails integrating economic, environmental and social considerations into decision-making processes, and addressing both short-term and long-term needs.

HSE MANAGEMENT SYSTEMS

The Muskeg River Mine HSE management systems identify expectations for the full implementation of HSE programs related to mine operations regarding:

HSE MANAGEMENT SYSTEMS (cont'd)

- leadership
- training
- risk management
- standards
- processes
- resources

The HSE management systems also outline the HSE:

- organizational structure
- roles and responsibilities
- governance
- assurance

Key components of the existing Muskeg River Mine HSE management systems include:

- Muskeg River Mine safe work practices
- emergency preparedness and response plans that address the risks, hazards and potential emergency scenarios associated with operating the mine
- an ISO 14001 registered environmental management system
- environmental operating procedures designed to help ensure full compliance with all operating approvals and licences
- stakeholder engagement and community notification systems

PIERRE RIVER MINE PHYSIOGRAPHY

Lease 9 is situated on the western bank of the Athabasca River, about 25 km north of the Muskeg River Mine, and 95 km north of Fort McMurray. Lease 9 holds the principal resource for the Pierre River Mine. Other resources in various stages of definition occur north of Lease 9, in Leases 17, 309, 310, 351 and 352. These are all held by Shell and occur along the west side of the Athabasca River as far north as Township 100.

Two major features dominate the physiography of the Pierre River Mine area. Birch Mountain to the west runs almost north–south, paralleling the trend of the Shell leases. Its height peaks at over 800 masl, and decreases eastward to 340 masl over a distance of 5 km. The Athabasca River trends north–northwest east of the Shell leases, and truncates a broad terrace 15 to 20 km wide. Within this distance, the elevation of the topography declines from 340 masl at the foot of Birch Mountain to 250 masl at the west bank of the Athabasca River.

East of Lease 9, the Athabasca River appears to have remained in the same 600 m-wide channel for much of its history. However, downstream to the north, the width of the floodplain broadens to over 8 km, indicating much channel movement.

The elevation of the floodplain plateau is between 250 and 260 masl, compared with the elevation of the river water surface at about 225 masl. The floodplain is defined by the surface of a series of islands and former islands. Coming out of a meander to the left, at the northeast corner of Lease 17, the Athabasca River is on the west side of the floodplain. About 18 km downstream, entering a meander to the right, just north of Lease 309, the Athabasca River has migrated across to the east of the floodplain.

Several minor watercourses enter the Athabasca River from the west, having flowed across the terrace from Birch Mountain. Some of them have eroded channels up to 30 m deep by the time they enter the Athabasca River. The Pierre River flows into the Athabasca River just south of Lease 9, Eymundson Creek enters the Athabasca River 6 km downstream, still in Lease 9, and Big Creek flows into an abandoned channel of the Athabasca River, midway along the east margin of Lease 351.

Muskeg, with some standing water, trends up the eastern side of Lease 17 to the western side of Lease 351. Cranberry Lake is about central to Lease 17, and

PIERRE RIVER MINE PHYSIOGRAPHY (cont'd)

Small Sandy Lake and Oakley Lake are located toward the west in Lease 351. Figure 3-1 shows the topography of the area.

PRE-CRETACEOUS FORMATIONS

Middle Devonian strata underlying the McMurray oil sands are subdivided (in descending stratigraphic order) into the:

- Beaverhill Lake Group, including the Waterways, Slave Point and Fort Vermilion formations
- Elk Point Group, which includes the Watt Mountain, Muskeg (Prairie Evaporite), Keg River (Methy), Contact Rapids and Lower Devonian La Loche formations

The Devonian strata consist of alternating carbonates and calcareous mudstones. The only trace remaining of the Prairie Evaporite sequence is gypsum. The general understanding of the Devonian sequence is that it dips westward. However, faulting might also be involved because older strata than expected has been eroded and overlain by Cretaceous, Pleistocene and Holocene materials. Erosion has resulted in a broad unconformity on the tilted sequence, creating a ridge-and-valley style topography in the Devonian.

CRETACEOUS FORMATIONS

The McMurray Formation overlies the unconformity developed on the Devonian strata. Sedimentation, initiated in response to a rise in sea level, was strongly controlled by the paleotopography of the unconformity surface, causing the McMurray Formation to be deposited within a large northwest-trending valley. Fluvial channel sands and associated flood plain deposits made up the early continental environment. Shallow marine sands and shales topped subsequent estuarine channel and tidal flat deposits. The marine influence increased stratigraphically upward as the Boreal Sea transgressed from north to south.

The primary subdivisions of the McMurray Formation are based on a three-part environmental assemblage, consisting of early continental, estuarine and late marine deposition. Sediments laid down in each environment are designated lower (LM), middle (MM) and upper (UM) McMurray members, indicating their relative position.

Overlying the McMurray Formation are the Wabiskaw, Clearwater and Grand Rapids formations. The complete succession, including the McMurray Formation, makes up the Mannville Group. Above the Mannville, forming Birch Mountain, are the Joli Fou Formation, the Viking Formation and strata of the La Biche Group.

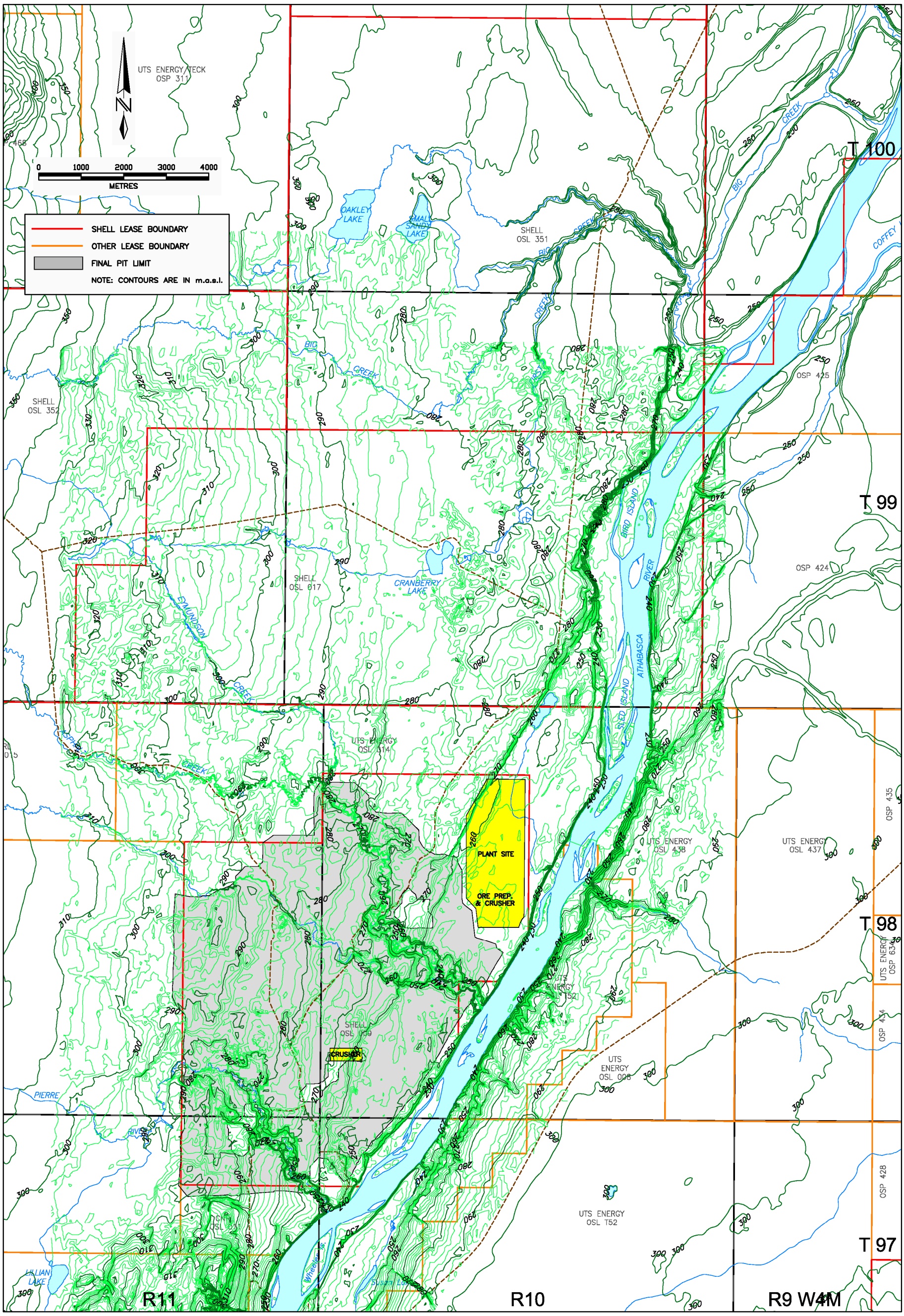


Figure 3-1: Topography of the Pierre River Mine Area

QUATERNARY DEPOSITS

Quaternary deposits directly overlie the Cretaceous strata. Pleistocene deposits consist of glaciofluvial sheet sands with minor gravel lenses and shallow channel sands. Within Lease 9, Pleistocene accumulations increase gradually from about 5 m on the west bank of the Athabasca River, to greater than 35 m thick in the northwest corner of the lease, over a distance of 6 km. North of Lease 9, the deposition of overburden materials is dominated by what might be a paleochannel of the Athabasca River. More than 9 km west of the present position of the Athabasca channel, a former meander has excavated the McMurray Formation to a depth of over 70 m. This increases to over 100 m within 4 km of the present Athabasca channel. Overall, the thick Holocene meander belt deposition extends more than 25 km northeast of Lease 9.

Holocene deposits generally consist of organic muskeg, and soft, water-saturated clay underlying the lakes and ponds. The meander belt includes a complete range of sediment, from clays and silts through generally poorly sorted sands, to gravel, cobbles and boulders.

DEVONIAN FORMATIONS

As the regional Cretaceous–Devonian contact is unconformable, the age of the Devonian member underlying the McMurray Formation varies. The specific Devonian stratum beneath the Pierre River Mine area ranges from the Firebag Member to the upper part of the Slave Point Formation. The Firebag Member consists of calcareous shale and nodular to micritic limestone with some crinoid and brachiopod fossils, to dolomitic limestone in the Slave Point.

Lease 9 has a generally subdued trend in Devonian elevations. The Devonian dips below 170 masl in the northeast corner, and reaches over 260 masl in the southwest, but throughout a 5 km-wide central portion, it varies between 200 and 220 masl. Significantly, the thickening trends in the McMurray Formation ore correspond to the minor deepening in the Devonian surface.

To the north of Lease 9, in an area of over 45 km^2, throughout most of Lease 309 and a large portion in the north of Lease 351, the overburden deposits lie directly on the Devonian at a depth of 70 m to over 100 m.

The elevation of the Devonian is below 200 masl throughout the meander area, as much as 5.5 km west of, and roughly parallel to, the current position of the Athabasca River. The Devonian rises onto a plateau about 220 masl in the western portion of Lease 351, with the strike trend running southwest–northeast across the lease. An isolated pocket of deeper Devonian occurs, delineated by three wells, in the northwest corner of Lease 351.

Within Lease 309, the Devonian undergoes a comparable deepening into the Athabasca River channel, while Lease 310, to the west, is underlain by the Devonian plateau. Beneath Lease 17, the Devonian surface dips as low as 160 masl to the east, an elevation similar to that beneath the Athabasca paleochannel, but actually overlain by a substantial thickness of lower McMurray Formation, and rises to over 250 masl to the west.

Figure 3-2 shows the Devonian top surface structure.

MCMURRAY FORMATION

In the Pierre River Mine area, within Lease 9, the Devonian surface has some influence over ore development in the McMurray Formation, as mentioned

MCMURRAY FORMATION (cont'd)

previously. Increased thickness of ore development in the estuarine sands of the middle McMurray is likely responsible.

Lower McMurray Member

The lower McMurray is absent over most of the Pierre River Mine area. It is present only to the east of Lease 9, within 3 to 4 km of the Athabasca River, and in a 5 km^2 area in the northeast corner of the lease where the entire continental assemblage can reach a thickness of 20 to 30 m. No coarse-grained fluvial sands, which contribute to ore, occur. All fluvial sands are water saturated. Some ore bodies have been logged as distributary channel sands, and the continental sediments of the lower McMurray also comprise extended sequences of muds and silts, interpreted to have been laid down in marsh conditions, coal swamps and overbank deposits. The distributary channels are similar in character and stratigraphic position, and could be connected laterally with estuarine sands of the middle McMurray.

North of Lease 9, the pattern is the same for the lower McMurray, i.e., mud and silt with some bitumen-bearing distributary channel sands, over barren fluvial channel sands. The thickness of the continental package varies widely, from 0 m, to more than 75 m in the isolated Devonian in the northwest corner of Lease 351, where 50 m of mud and silt overlie 27 m of watersand. Overall, the thick McMurray Formation accumulation in the east-central area of Lease 17, and its continuation beneath the southeast quadrant of Lease 351, largely consists of lower McMurray strata (see Figure 3-3).

Middle McMurray Member

The middle McMurray consists of estuarine and tidal channels succeeded by a mixture of tidal flats facies. The estuarine channels average about 10 m thick through much of Lease 9, and contain at least 14% bitumen (by weight). Above this, the rest of the ore zone is largely made up of tidal channel deposits, and any variation in total ore thickness is the result of interfingering of flats facies with the channels.

In the area north of the Pierre River Mine, the estuarine channel development, if any, is limited to 1 to 2 m. However, it is generally bitumen-saturated. Even where the lower McMurray is fully developed, the estuarine component is very thin.

Where they exist, primarily in the western portions of Leases 17, 310 and 351, and the eastern portion of Lease 352, as far as it has been drilled, the tidal channel and flats sequences seem well saturated with bitumen. The bitumen grade fluctuates broadly, from less than 1% to more than 14%, depending on the fines content of the host sediment. Minimal flushing by water has been observed. The tidal complex can be up to 45 m thick but tapers to 0 m north of Lease 17, and a short distance east into Lease 351. The thickness of McMurray Formation deposits to the west in Lease 17, and in Lease 352, consists mainly of middle McMurray tidal.

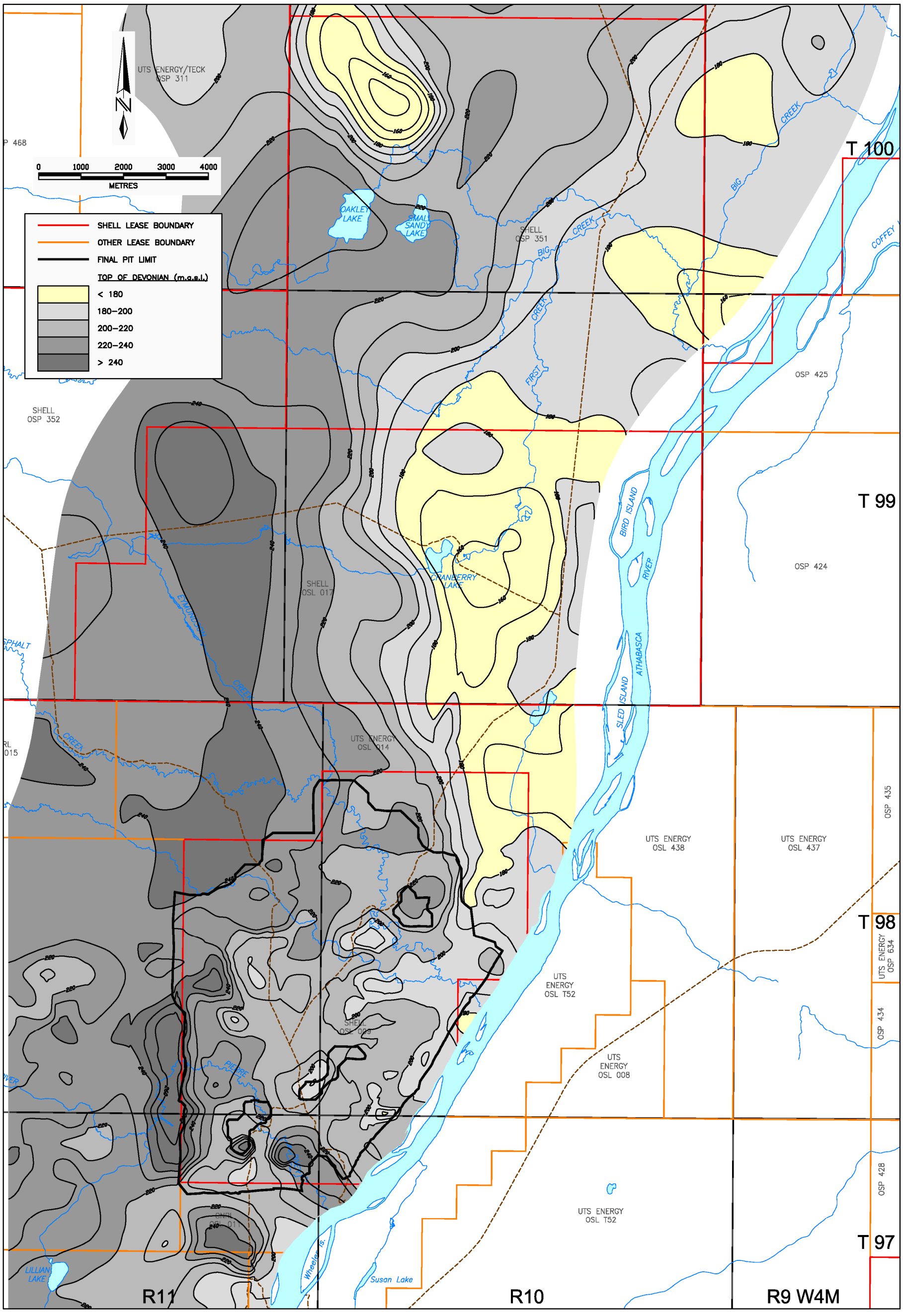


Figure 3-2: Devonian Surface

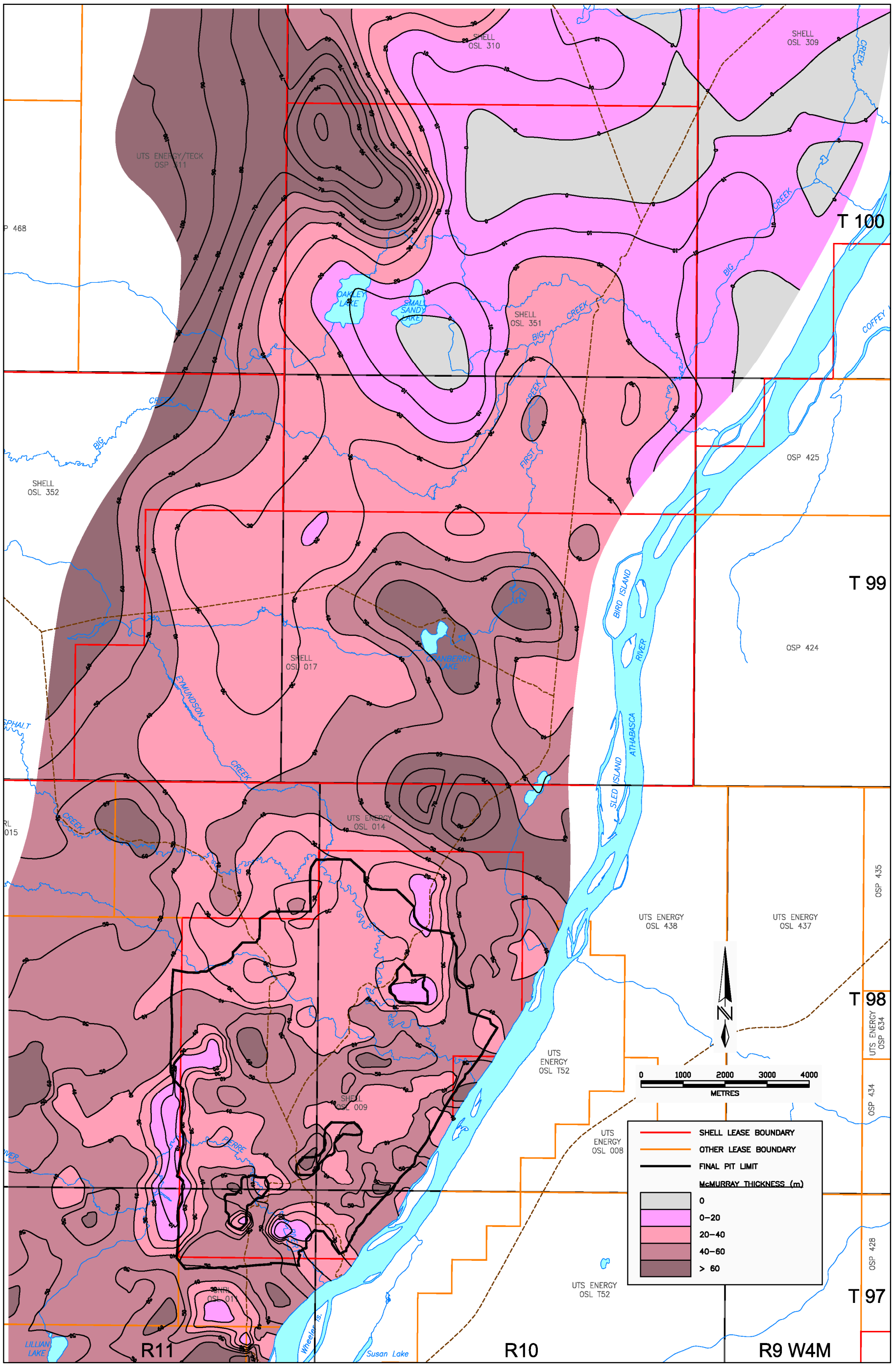


Figure 3-3: McMurray Formation Isopach

Upper McMurray Member

No upper McMurray member occurs within the Pierre River Mine area. However, the marine member has been recognized on a north–south trend within Lease 352. It consists of fine to medium to coarse-grained sands, with trace to intense bioturbation, interbedded with wavy to thinly bedded black shale. The intensity of clay interbedding varies with the environment. Nearshore deposition is interpreted to have fewer clay bands than that farther from the shore. The sands are well saturated with bitumen, and make up a substantial part of the resource in this area. At the maximum thickness, almost 20 m of marine channel sands occur with up to 14% bitumen.

LITHOFACIES CODING

The stratigraphy throughout the area in which Shell has lease holdings varies around a central scheme. This scheme was developed for the Muskeg River Mine and includes the following units:

Overburden Member

The overburden (OV) member comprises post-McMurray deposits consisting of:

- unconsolidated and partially cemented tills
- outwash sands and gravels
- reworked bituminous sands
- a major Pleistocene channel on the east side of the Athabasca River

The OV member is generally 8 to 10 m thick, except in the Pleistocene channel valley, where it can be over 50 m thick.

Upper McMurray Member

The Upper McMurray (UM) member consists of marine, lightly to intensely bioturbated muds, is wavy to thinly laminated with shale, but otherwise is composed of fine to medium-grained sand with over 15% bitumen.

Middle McMurray 2 Member

The Middle McMurray 2 (MM2) member comprises tidal flat and channel deposits.

Middle McMurray 1 Member

The Middle McMurray 1 (MM1) member contains estuarine facies.

Lower McMurray 2 Member

The Lower McMurray 2 (LM2) member consists predominantly of lagoonal mud or shale, with interbedded fine sand or silt. Upward, the mud is massive and includes rootlets and widely distributed coal laminae. Lower in the member,

Lower McMurray 2 Member (cont'd)

interpreted environments include barrier beaches, distributary channels and tidal deltas. Figure 3-4 shows the LM2 isopach.

Lower McMurray 1 Member

The Lower McMurray 1 (LM1) is a bitumen-saturated fluvial channel sand. It does not occur in the Pierre River Mine area or north of Lease 9.

Lower McMurray 1 (LM1w) Member

All fluvial sands in the Pierre River Mine area are water-saturated. Figure 3-5 shows the LM1w isopach.

Devonian Waterways Member

The portion of the Devonian Waterways (DW) Formation underlying the Pierre River Mine area is mostly from the Calmut and Firebag members. Calmut is an extensively mottled and bioturbated limestone, with occasional fossil bands. The Firebag can include nodular or argillaceous limestone and dark greenish-grey calcareous mud.

FACIES

For core description, the members are further divided into facies. Facies recognition involves differentiating sedimentary units using sedimentary characteristics, including:

- grain size
- sorting
- rounding
- sedimentary structures
- degree of biological disturbance
- fossil content
- sand and mud ratio

Figure 3-6 shows the current facies scheme used for logging core.

POST-MCMURRAY DEPOSITS

Post-McMurray deposits occurring in the Athabasca area include the Cretaceous Wabiskaw, Clearwater and Grand Rapids formations and Quaternary deposits of the Pleistocene and Holocene. Regionally, the Wabiskaw, Clearwater and Grand Rapids formations are flat-lying marine sediments consisting of shale and sandstone.

Thick overburden accumulation requires additional stripping, but might also contribute to geotechnical complications. Where the marine clays of the

Clearwater Formation have not been eroded before the deposition of glacial materials, they must often be removed to ensure firm footing beneath elements of mine infrastructure. Clearwater Formation deposits can occur at the western edge of the drilling pattern in Lease 352.

In 2006 and 2007, just under 100 auger holes were initiated to evaluate overburden materials. This data was used to attempt to assess the areal distribution of muskeg thickness and glacial deposits. Unfortunately, the maximum capacity of the auger became an issue in many of these holes. As the depth of overburden frequently far exceeded 30 to 35 m, the auger was unable to establish the core point by reaching the McMurray Formation, particularly in the northern leases. North of Lease 9, only one auger hole reached the McMurray Formation in 30 attempts, while 14 of 16 holes intersected the McMurray Formation within Lease 9 in 2007. In 2006, the auger and core drilling were largely restricted to Lease 9, and 29 auger holes reached the McMurray Formation in 43 attempts. The success ratio north of Lease 9 was 0 in 7 attempts. Figure 3-7 shows overburden survey data locations. This phenomenon was noted predominantly north and east of Lease 9. The 2008 drilling program is centred to the west of Leases 17 and 351 and in Lease 352, where the 2007 drilling results were particularly encouraging.

The depth to McMurray, or to the Devonian where the McMurray Formation is absent, has been established at every core location, either by logging core or estimating from wireline logs. This is the basis of the isopach map in Figure 3-8.

TILL

The overburden accumulation in the Pierre River Mine area has been logged in a manner consistent with the scheme at the Muskeg River Mine. Generally, the till is divided into two categories, derived from two glacial events.

A top till sheet (Pg1) is characterized by:

- silty, sandy or gravelly clay
- a brown colour that can be oxidized to pinkish brown
- low plasticity
- moisture

The bottom till sheet (Pg2) consists largely of reworked McMurray Formation and is characterized by:

- silty, sandy or gravelly to sandy clay
- a grey colour
- medium plasticity
- a faint to strong bituminous odour
- lower moisture content than Pg1

TILL (cont'd)

However, in practice, because a sufficiently detailed survey has not yet been conducted, it is difficult to confidently separate the Pleistocene from the Holocene, or to differentiate the till sheets from one another.

MUSKEG

The auger survey does not include much muskeg. Of about 100 auger holes in 2006 and 2007, muskeg was identified in just 16, and only four holes had over 1 m of muskeg. Further refinement of the auger survey, or obtaining other surficial data, would be necessary before any definitive conclusions could be drawn regarding muskeg.

GRANULAR DEPOSITS

Preliminary indications suggest a modest accumulation of granular material in the Pierre River Mine area. The overburden is mostly clay or silt with sparse gravel in quantities of 2% to 5%, or fine to coarse sand. Towards the northwest corner of Lease 351 is evidence of a thickness of at least 15 m of boulders at a 30 m depth. However, these boulders might be at some distance below the bitumen resource and could require dedicated exploitation. More drilling will help to delineate the extent and accessibility of this particular granular resource.

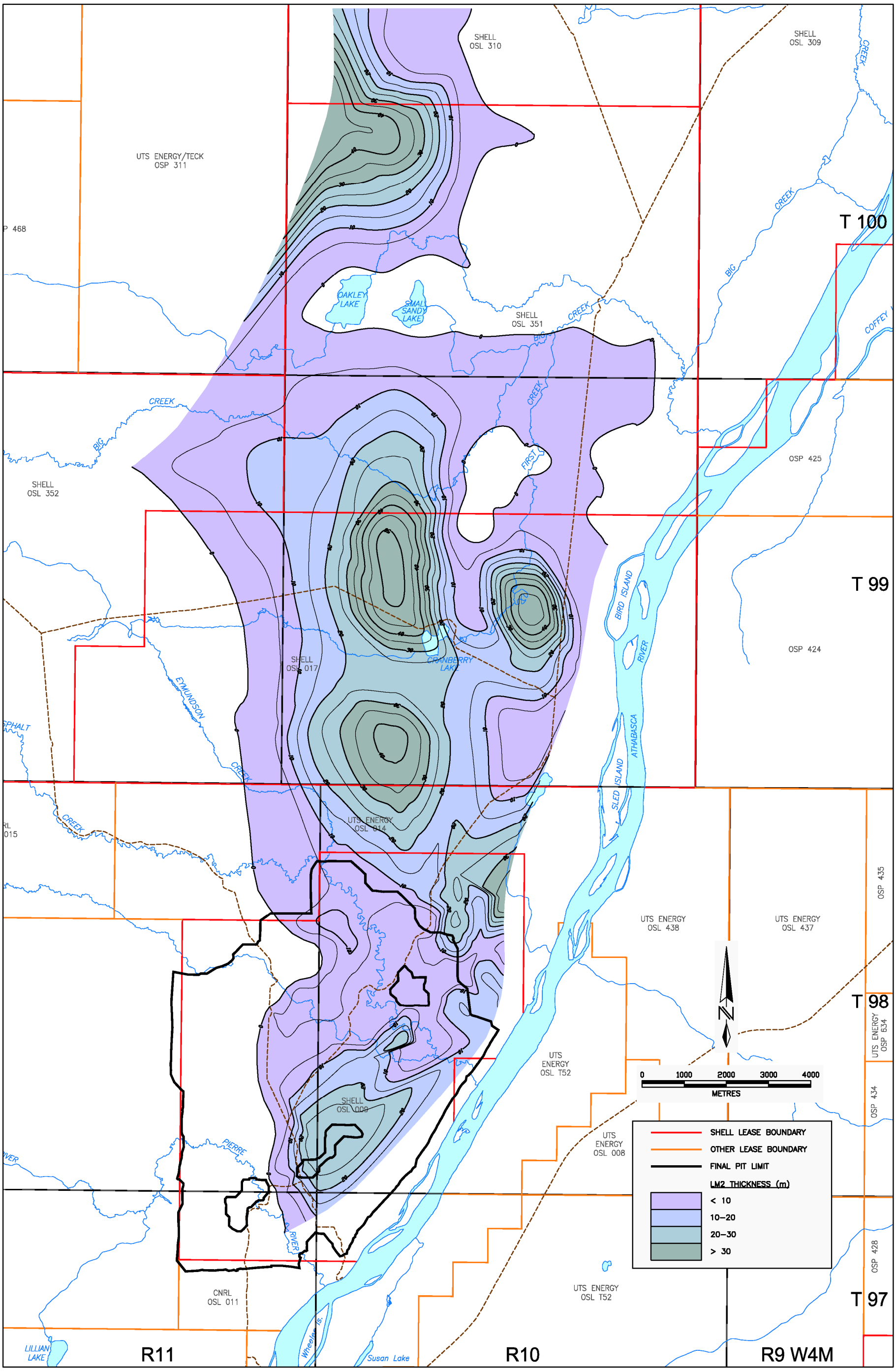


Figure 3-4: LM2 Isopach

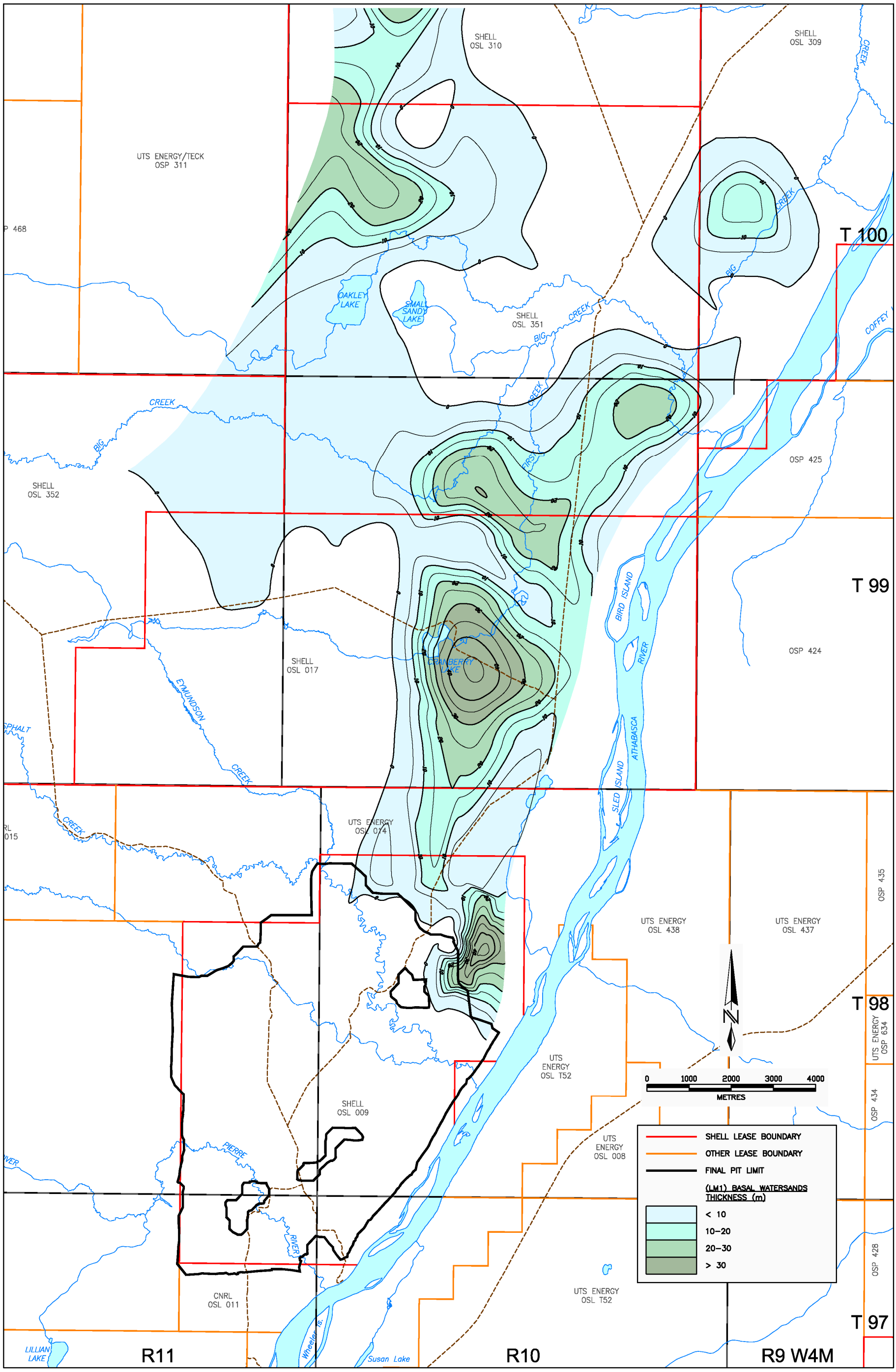


Figure 3-5: Basal Watersands (LM1w) Isopach

AGE	FORMATION	MEMBER	MEMBER CODE	DEPOSITIONAL SETTING	DEPOSITIONAL ENVIRONMENT	DEPOSITIONAL FACIES	SUBFACIES (Ore Zones Highlighted)	DOMINANT LITHOLOGY	ALBIAN SANDS SYMBOLS		PROPOSED COLOR SCHEME	PROPOSED HATCHURE SCHEME	PROPOSED COMPUTER CODE	JI ZONE	SHELL SYMBOL (Old Symbol)	SHELL CODE(Old Code)	DESCRIPTION
Holocene (0 - 11,000 YBP)									see Alsands/Landmark classification				6000				
Pleistocene (11,000 - 1,600,000 YBP)													5000				
	Clearwater Fm. - Cretaceous (Albian Epoch, 97.5 - 113 MYBP)								KC				4000				
		MARINE UNITS															
EARLY CRETACEOUS (97.5 – 144 MYBP)	McMURRAY FORMATION (113 - 119 MYBP)	UPPER McMURRAY	UM	MARINE ENVIRONMENT	Off-shore	Offshore Mud		Clay	OSM				3670	1	OSM	17	**Offshore Mud** - massive clay, very dark grey to black colored with less than 5% silt/sand lenses or burrow fills; of geotechnical concern
					Drowned Channel Scour Infill	"Marine Channel"	Upper Fill	Sand, Clay	MC (3654)	UMC			3656	--	MSF (Channel)	---	**"Marine Channel" Upper Fill** - well sorted fine to medium grained sands with 10 - 30% interbeds of dark grey to black colored well bedded clay/mud.
							Middle Fill	Sand, Clay		MMC							**"Marine Channel" Middle Fill** - well sorted fine to medium grained sands with 30 - 60% interbeds of dark grey to black colored well bedded clay/mud.
							Lower Fill	Sand, Clay		LMC			3652	--		---	**"Marine Channel" Lower Fill** - dark grey to black colored well bedded clay/mud with 10% - 40% interbeds of sand/silt, of geotechnical concern.
							Marine Breccia	Sand	MB				3640	--	---	---	**Marine Breccia** - fine to medium, maybe coarse grained, well sorted sands with greater than 10% mud/clay clasts.
						Marine Lagoonal Mud		Clay	MLM				3610	---	---	---	**Marine Lagoonal Mud** - dark grey to black colored well bedded massive clay/mud; low density, of geotechnical concern.
					Nearshore Marine	Beach	Foreshore	Sand	FS				3630	1	B	16	**Foreshore** - fine to medium maybe coarse grained well sorted sands, low angle bedded & cross bedded.
						Shoreface	Upper Shoreface	Sand	SF (3620)	USF			3626	1	MSF (marine shoreface)	15	**Upper Shoreface** - fine to medium grained well sorted sands, may be coarse, with 10 - 30% interbeds of wavy parallel to non-parallel dark grey to black clay/mud beds(l); burrowed.
							Middle Shoreface	Sand		MSF			3624	1			**Middle Shoreface** - fine to medium grained well sorted sands with 30% - 60% interbeds of wavy parallel to non-parallel dark grey to black clay/mud beds; burrowed.
							Lower Shoreface	Clay		LSF			3622	1			**Lower Shoreface** - dark grey to black clay/mud with 10% - 40% interbeds of thin sand/silt beds/laminae/flat lenses, burrowed; of geotechnical concern.
		TIDAL UNITS															
					Supratidal	Mud Flat		Clay	MF				3580	--	---	---	**Mud Flat** - light to medium grey to creamy colored massive maybe well burrowed silty mud with less than 10% sand/silt lenses, thin beds or burrow fills; low angle to horizontal bedded; maybe rooted and may have scattered carbonaceous debris.
					Intertidal	Tidal Flats	Tidal Flat Mud	Clay	TFM				3570	1	TFM	13	**Tidal Flat Mud** - light to medium grey maybe creamy colored massive or burrowed silty mud, with 10% - 40% silt/sand thin beds interbedded, burrow fills or dispersed; with low angle dips.
							Tidal Flat Mixed	Sand, Clay	TFX				3560	--	---	---	**Tidal Flat Mixed** - very fine to fine grained sands, may be silty with 30% - 60% light to medium grey, maybe creamy colored massive or burrowed silty mud beds interbedded, burrow fills or dispersed; with low angle dips.
							Tidal Flat Sand	Sand	TFS				3550	1	TFS	14	**Tidal Flat Sand** - very fine to fine grained sands, may be silty with 10 - 30% light to medium grey, maybe creamy colored massive or burrowed silty mud beds interbedded, burrow fills or dispersed; with low angle dips.
							Tidal Creek	Sand	TCR					2	TC	11	**Tidal Creek** - very fine to fine grained sands, usually homogeneous but may be small scale cross bedded with less than 10% mud in the matrix or as interbeds and occurs in the intertidal zone. Usually less than a meter thick.
					Subtidal (Channel Complex)	Upper Estuarine/Tidal Channel Complex*	Tidal Channel Margin	TC Top	Clay	TCT							**Tidal Channel Top** - light to medium grey colored massive or burrowed silty mud with less than 40% interbeds of millimeter to centimeter thick silty sand beds. Usually associated with tidal channel units
								TC Margin	Sand	TCM			3530	--	---	---	**Tidal Channel Margin** - very fine to fine grained sands, may be silty, with 10% - 30% interbeds of massive or burrowed silty mud beds.
							Tidal Channel Breccia		Sand	TCB			3510	2	TCB	9	**Tidal Channel Breccia** - very fine to fine grained sands with greater than 10% silty mud/mud clasts.
							Tidal Channel	Tidal Channel	Sand	TC (3522)	TC		3522	2	TC	11	**Tidal Channel** - very fine to fine grained may be medium grained sands, may be silty, with less than 10% silty mud beds or dispersed. The unit is parallel bedded, small scale x-bedded or may be massive. Often has sharp scoured basal contact.
								TC Mud	Mud		TM		3524	3	TCM	8	**Tidal Channel Mud** - light to medium grey massive mud may be silty, often soft, laminated to bedded, with high angled dips; of geotechnical concern.
								Tidal Channel	Sand		TC		3522	2	TC	11	**Tidal Channel Coarse** - medium grained sands and coarser, maybe silty, with less than 10% silty mud beds or dispersed. The unit is usually planar bedded & graded bedded but may also be massive. Often has sharp scoured basal contact.
						*maybe present in the Intertidal Zone											
						ESTUARINE UNITS											
			MM1		Subtidal (Channel Complex)	Lower Estuarine	Estuarine Channel Margin	EC Top	Sand	ECT			3436	--	---	---	**Estuarine Channel Top** - fine to medium grained sands with 30% - 60% silty mud/mud beds interbedded or dispersed; usually associated with estuarine channel units.
								EC Margin	Sand	ECM			3432	--	---	---	**Estuarine Channel Margin** - fine to medium grained sands, may be coarse, with 10% - 30% silty mud beds interbedded; the mud beds have sharp top and basal contacts with the sands; usually associated with estuarine channel units.
							Estuarine Channel Breccia		Sand	ECB			3410	--	---	---	**Estuarine Channel Breccia** - fine to medium grained sands, may be coarse grained, with greater than 10% silty mud/mud clasts.
							Estuarine Channel	EC fine	Sand	EC (3420)	ECf		3426	2	TCFC	10	**Estuarine Channel** - fine to medium grained sands with less than 10% mud beds interbedded; may be silty and may have light to moderate carbonaceous debris scattered and/or carbonaceous beds interbedded; generally parallel bedded, cross bedded and maybe graded bedded.
								EC Mud	Mud		EM		3424				**Estuarine Channel Mud** - light to medium grey colored mud, may be silty, often soft, laminated to bedded, with high dips, of geotechnical concern.
								EC coarse	Sand		ECc		3422				**Estuarine Channel Coarse** - medium to coarse grained sands, may be pebbly, with less than 10% mud beds interbedded; may be silty and may have light to moderate carbonaceous debris scattered and/or carbonaceous beds interbedded; generally parallel bedded, cross bedded and graded bedded.
							Estuarine Tidal Channel Complex										**Estuarine Tidal Channel Complex** - may be present below the Estuarine Channel Sands; same as above Upper Estuarine Tidal Channel facies and facies description. Can occur under, above, or within the Estuarine Tidal flats.
							Estuarine Tidal Flats										**Estuarine Tidal Flats** - may be present above or below the Estuarine Channel Sands; same as above Tidal Flats facies and facies description.
							Estuarine Chan watersand		Sand	ECw			3419	--	--	--	**Estuarine Channel Watersand** - same as above Estuarine Channel but wet, and with bitumen less than 5%.

Figure 3-6: Member and Facies Codes

AGE	FORMATION	MEMBER	MEMBER CODE	DEPOSITIONAL SETTING	DEPOSITIONAL ENVIRONMENT	DEPOSITIONAL FACIES	SUBFACIES (Ore Zones Highlighted)	DOMINANT LITHOLOGY	ALBIAN SANDS SYMBOLS		PROPOSED COLOR SCHEME	PROPOSED HATCHURE SCHEME	PROPOSED COMPUTER CODE	JI ZONE	SHELL SYMBOL (Old Symbol)	SHELL CODE(Old Code)	DESCRIPTION
						CONTINENTAL/FLUVIAL UNITS											
	(Aptian Epoch, 113 - 119 MYBP)	LOWER McMURRAY	LM2	CONTINENTAL ENVIRONMENT (Fluvial Coastal Plain)	Flood Plain	Flood Basin	Back Swamp	Clay	BS				3360	--	---	---	**Back Swamp** - dark grey to black low density carbonaceous mud (greater than 30% carbonaceous content) with numerous carbonaceous debris scattered throughout or in places; generally slickensided; of geotechnical concern.
							Coal Swamp	Coal	C0				3350	3	CS	6	**Coal Swamp** - coal bed; may be clayey or silty.
							Marsh	Clay	M				3340	3	TLM	7	**Marsh** - light to medium grey may be creamy colored mud; homogeneous, massive and rooted; sometimes slickensided; of geotechnical concern.
						Crevasse Splay		Sand	CS				3330	--	---	---	**Crevasse Splay** - very silty or muddy poorly sorted fine to medium and coarse grained sands, with chaotic bedding and sometimes with scattered carbonaceous debris and/or interbedded carbonaceous beds.
						Crevasse Splay watersand		Sand	CSw				3329	---	---	---	**Crevasse Splay watersand** - same as above Crevasse Splay but wet.
						Distributary Channel	DC Top		DCT					3	FCPB	5	**Distributary Channel Top** - light to medium grey colored silty mud with less than 30% silty sand interbeds or dispersed, poorly sorted and maybe burrowed with planolites or scoyenia burrows.
							DC Margin		DCM								**Distributary Channel Margin** - fine to medium grained sands with 10 to 30% silty mud beds interbedded or dispersed.
							Dist. Channel	Sand	DC				3320				**Distributary Channel** - fine to medium grained sands with occas(s)ional scattered coarse sand, cross bedded or current rippled, with scour and fill structures.
						Distributary Channel ws	DC Top ws		DCTw					3	FCPB	5	**Distributary Channel Top watersand** - same as above Distributary Channel top but wet.
							DC Margin ws		DCMw								**Distributary Channel Margin watersand** - same as above Distributary Channel Margin but wet.
							Dist Chan ws	Sand	DCw				3319				**Distributary Channel watersand** - same as Distributary Channel above, but wet.
						Flood Plain	Flood Plain	Clay	FP				3316	4	FPOB	3	**Flood Plain** - light to dark grey colored well bedded mud, with less than 10% sand/silt beds/laminae; the unit may appear varved.
							FP/Overbank	Clay	FPOB					4	FPOB	3	**Flood Plain - Overbank** - light to dark grey silty mud with 10 to 50% silt/sands dispersed in the matrix, poorly sorted and usually burrowed with planolites or scoyenia burrows.
							Overbank	Clay	OB				3312	4	FPOB	3	**Overbank** - massive homogenous silty mud with 10% - 30% dispersed silt/sands; maybe rooted (marshy) or churned.
			LM1		Channel Complex	Fluvial Channel Margin	FC Top	Mud/Sand	FCM	FCT			3246	--	---	---	**Fluvial Channel Top** - light to medium grey colored silty mud/mud with less than 40% interbedded fine to medium or coarse grained sands, may have thin carbonaceous beds or carbonaceous debris scattered; associated with fluvial channel units.
							FC Margin	Sand		FCM			3242	--	---	---	**Fluvial Channel Margin** - fine to medium or coarse grained sands with 10% - 30% silty mud/mud beds interbedded; may have thin carbonaceous beds or carbonaceous debris scattered; associated with fluvial channel sands.
						Fluvial Channel Breccia		Sand	FCB				3230	--	---	---	**Fluvial Channel Breccia** - fine to medium or coarse grained sand with greater than 10% silty mud clasts, may have scattered carbonaceous debris.
						Fluvial Chan Flood Plain		Clay	FFP				3216	--	--	--	**Fluvial Channel Flood Plain** - light and dark grey colored bedded silty muds, with 10% - 30% millimeter thick sand/silt beds interbedded; the unit may appear varved; usually associated with fluvial channel sediments.
						Fluvial Channel	FC fine	Sand	FC (3220)	FCf			3226	4	FC	4	**Fluvial Channel Fine**- fine to medium grained sands with less than 10% silty mud beds or dispersed; with carbonaceous beds and/or scattered carbonaceous debris; generally parallel to incline parallel bedded, x-bedded and maybe graded bedded.
							FC Mud	Mud		FM			3224				**Fluvial Channel Mud** - light to medium grey mud, may be silty, often soft, laminated to bedded, with steep dips; of geotechnical concern.
							FC coarse	Sand		FCc			3222				**Fluvial Channel Coarse**- medium or very coarse grained sands, may be pebbly, with less than 10% silty mud beds or dispersed; with carbonaceous beds and/or scattered carbonaceous debris; generally parallel to inclined parallel bedded, x-bedded and graded bedded.
							Calcareous Arenite	Sand		FCL							**Calcareous Arenite** - well cemented massive homogeneous sandstone with calcareous cements; usually found associated with or close to proximity of collapse structures.
							Conglomerate			CGL							**Conglomerate** - medium to very coarse grained sands with greater than 30% granule size or larger size grains; usually poorly sorted, homogeneous and with scattered carbonaceous debris. Pyrite and siderite nodules may be present.
			LM1$_w$			Fluvial Channel Margin ws	FC Top ws	Mud/Sand	FCMw	FCTW				5	ws		**Fluvial Channel Top** - same as Fluvial Channel Top above but wet; with bitumen less than 5%.
							FC Margin ws	Sand		FCMw			3140			---	**Fluvial Channel Margin watersand** - same as Fluvial Channel Margin above but wet; with bitumen less than 5%.
						Fluvial Chan Breccia ws		Sand	FCBw				3130			---	**Fluvial Channel Breccia watersand** - same as Fluvial Channel Breccia above but wet.
						Fluvial Chan Flood Plain ws		Mud	FFPw				3116			---	**Fluvial Channel Flood Plain watersand** - same as Fluvial Channel Flood Plain but wet.
						Fluvial Channel watersand	FC Chan Mud ws	Mud	FCw	FMw			3124			---	**Fluvial Channel Mud watersand** - same as Fluvial Channel Mud above but wet.
							FC Chan ws	Sand		FCw			3110			---	**Fluvial Channel watersand** - same as Fluvial Channel above but wet, and with bitumen less than 5%.
							Calc Arenite ws	Sand		FCLw							**Calcareous Arenite watersand** - same as above Calcareous Arenite but associated with watersands.
							Conglomerate ws	Sand		CGLw			3120	--	---	---	**Conglomerate watersand** - same as above Conglomerate but wet.
						Erosional Unconformity											
DEVONIAN (360-408 MYBP)	WATERWAYS (373-375 MYBP)		DW			Paleosol			Psol				2050	6		2	**Paleosol** - yellowish to buff colored sometimes iron stained limy soil, limy.
						Limy Shale			Limy SH					6		1	**Limy Shale** - well bedded and platy limy shale, may slightly fizz with acid
						Calcareous Shale			Calc SH					6		1	**Calcareous Shale** - well bedded and platy calcareous shale, fizzes strongly with acid.
						Argillaceous Limestone			Arg LS				2040	6		1	**Argillaceous Limestone** - Calcareous shale with 5 to 25% nodules.
						Nodular Limestone			Nod LS				2020	6		1	**Nodular Limestone** - with greater than 25% nodular structures or nodules.
						Fossiliferous Limestone			Foss LS					6		1	**Fossiliferous Limestone** - highly fossiliferous nodular limestone, mostly crinoidal stems and brachiopod shells.
						Micritic Limestone			Mic LS				2030	6		1	**Micritic Limestone** - Microcrystalline limestone.
						Reefal Limestone			RF LS				2010	6		1	**Reefal Limestone** - with broken coral fragments & stromatoporoids, usually found in the Moberly Member of the Waterways Formation.

Note: Within a particular environment, the indivdual facies can occur in any order or can be repeated a number of times; only the boundaries between 'members' carry any time connotations.

Revised: Mel Estoque 10/02/06, Mel Estoque 12/30/02, Sources: T. Massoth & M. Estoque (1998), R. Dean (1997), Syncrude Canada Ltd Facies Chart.

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Figure 3-6: Member and Facies Codes (cont'd)

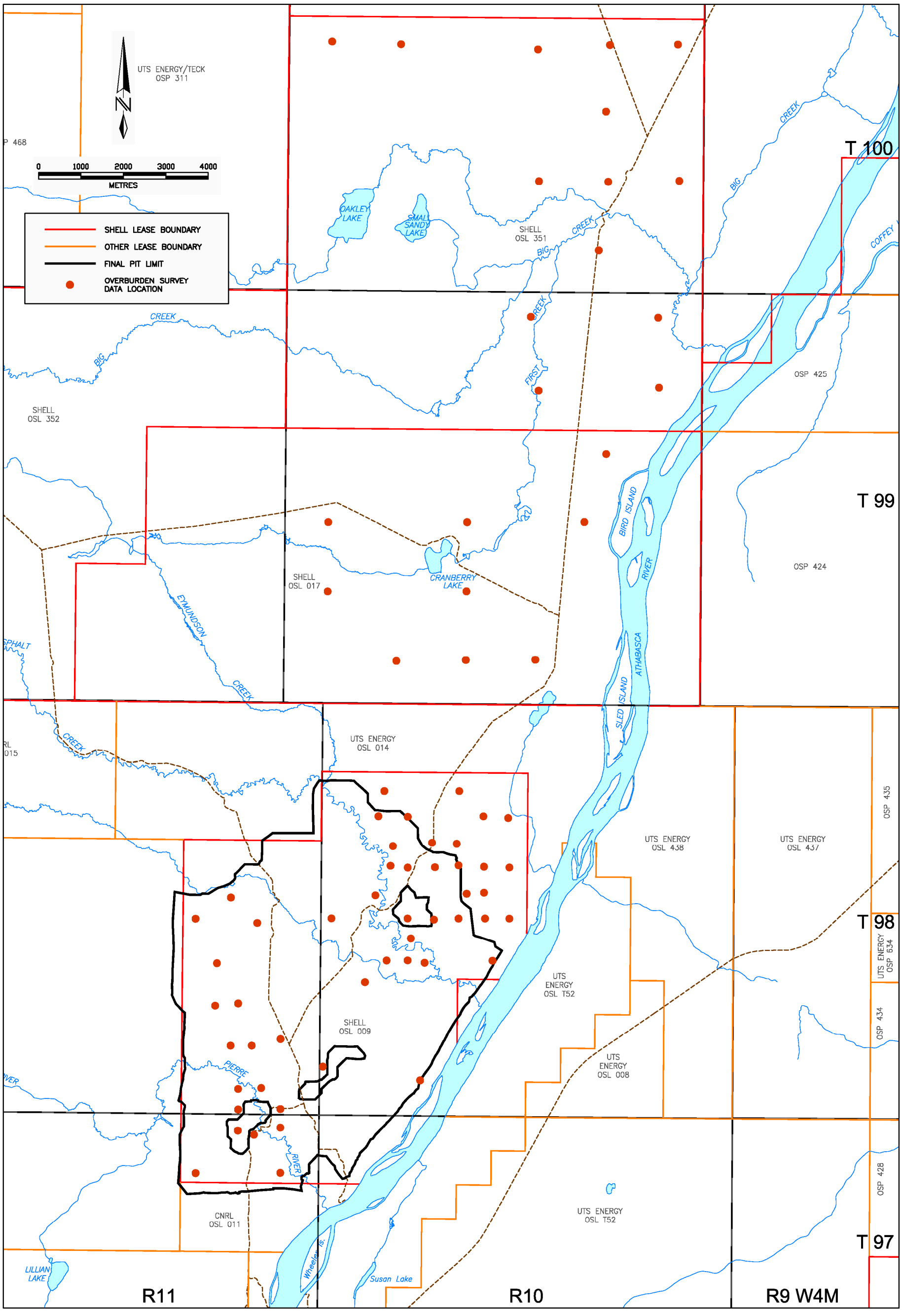


Figure 3-7: Overburden Survey Data Locations

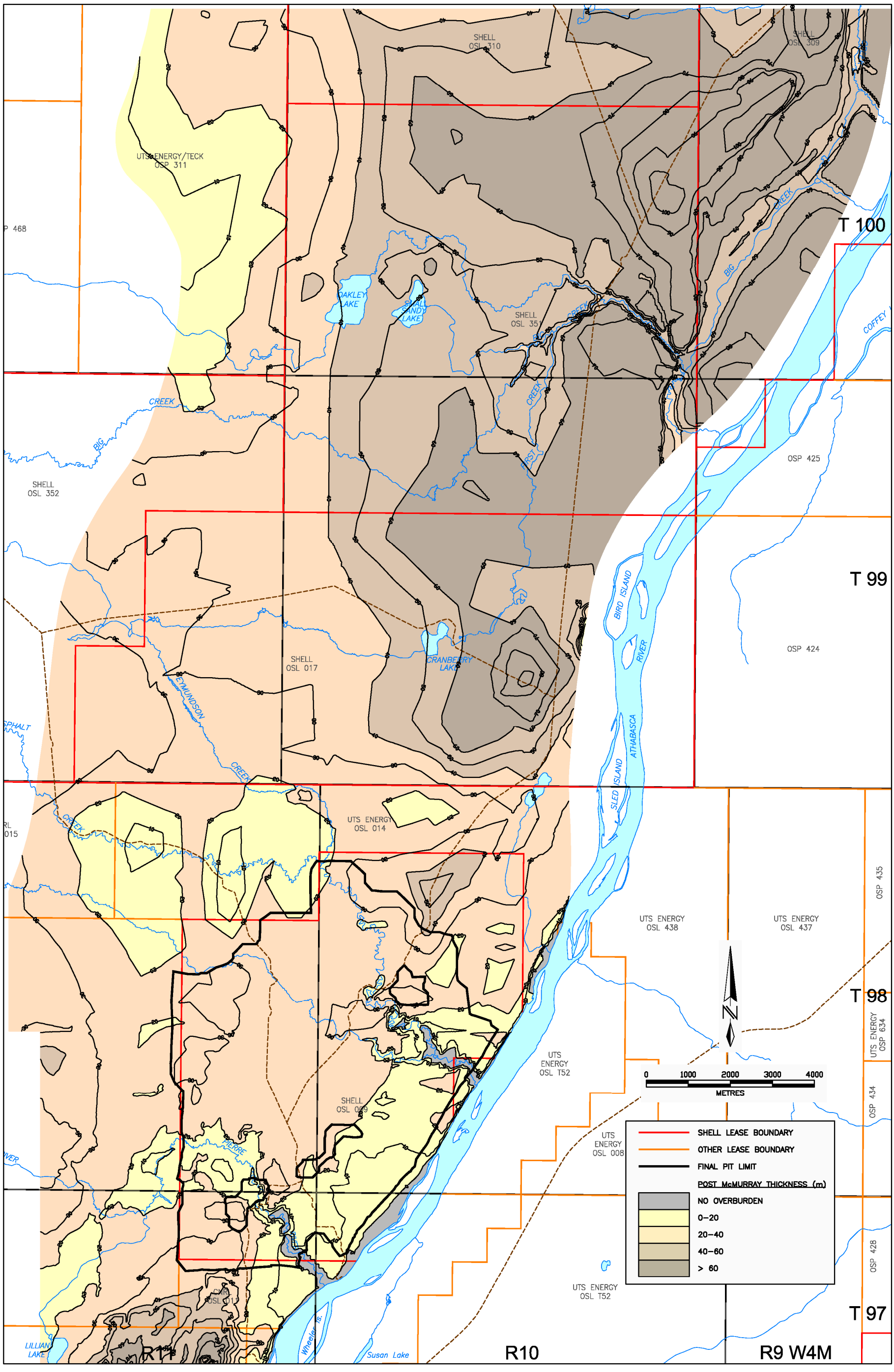


Figure 3-8: Post-McMurray Deposits Isopach

DRILLING HISTORY

Drilling is the principal tool used for delineating the resource within the Pierre River Mine area. Exploration core drilling in the Pierre River Mine area occurred during several development periods:

- 1953 – Madison Oil drilled a preliminary program of about 20 randomly scattered wells on Lease 9
- 1957 – a precursor of Petro-Canada drilled holes on a 400 m grid over four sections in the southeast of Lease 9. This established the heart of the resource in the Pierre River Mine area.
- 1960 to 1972 – a precursor of Husky Oil drilled 10 wells in 1967, at about a 1-mile spacing, over the six sections north of the Pierre River Mine. A few randomly spaced wells were also drilled between 1960 and 1972.
- 1982 – Petro-Canada drilled wells on a 1-km grid on Lease 9 as part of the far-ranging CanStar program
- 2006 – Shell drilled wells at various spacing, i.e., 600 m, 1 km and 1,200 m, infilling the previous drill pattern to reduce drill spacing to 400 to 600 m, and to allow assessment of the resource over the entire Pierre River Mine area
- 2007 – Shell drilled wells to complete the infill pattern north of the Pierre River Mine area. As well, 88 wells were drilled north of Lease 9 at a spacing of 1,600 to 3,200 m.
- 2008 – wells are planned to establish an 800 m spacing in western Lease 17 and Lease 352, as far west as the foot of Birch Mountain

This drilling resulted in the drill pattern shown in Figure 4-1. In recent years, UTS Energy Limited (UTS) has also done considerable drilling on:

- UTS Lease 14 (27 wells in 2006 and 49 wells in 2007), between Shell's Leases 9 and 17
- UTS/Teck Lease 311 (six wells in 2006 and 57 wells in 2007), west of Shell's Lease 351

The 2007 drilling done by UTS is not shown on the map and is not included in the block model.

DRILLING DENSITY

A broad range of exploratory drilling has yielded results of various quality. Wells that have been cored throughout their length produce superior results compared to uncored wells. Table 4-1 summarizes the wells in Lease 9 that have been drilled to date or that are proposed for 2007–2008.

Table 4-1: Pierre River Mine Drilling Summary

Year	Core Holes
1953	18
1957	57
1960–70s	15
1982	37
2006	58
2007	28
2008	108
Total	**321**

In the Lease 9 area, the drilling density is one well per 29.2 ha, or 8.9 wells per section. The drilling density of Leases 17, 309, 310, 351 and 352 is too sparse to provide a meaningful statistic. For the 2008 proposed drilling within the western part of Lease 17 and in Lease 352, the density will be one well per 116 ha, or 2.2 wells per section, if the drilling program is successful.

DRILLING RESULTS

All resource evaluation wells drilled by Shell since 1997 have been cored from the top of the McMurray Formation to between 3 and 5 m into the Devonian Waterways Formation. Each well was also geophysically logged, using wireline tools. The suite of logs provided included:

- gamma ray
- dual-focused electric (resistivity)
- compensated density
- dual-spaced neutron
- spontaneous potential
- caliper
- dipmeter
- verticality

Until Dean & Stark values are available, an algorithm is used to predict bitumen grade at 10 cm intervals downhole. The calculation uses readings from the gamma ray and resistivity curves, indicating the resource potential in an area.

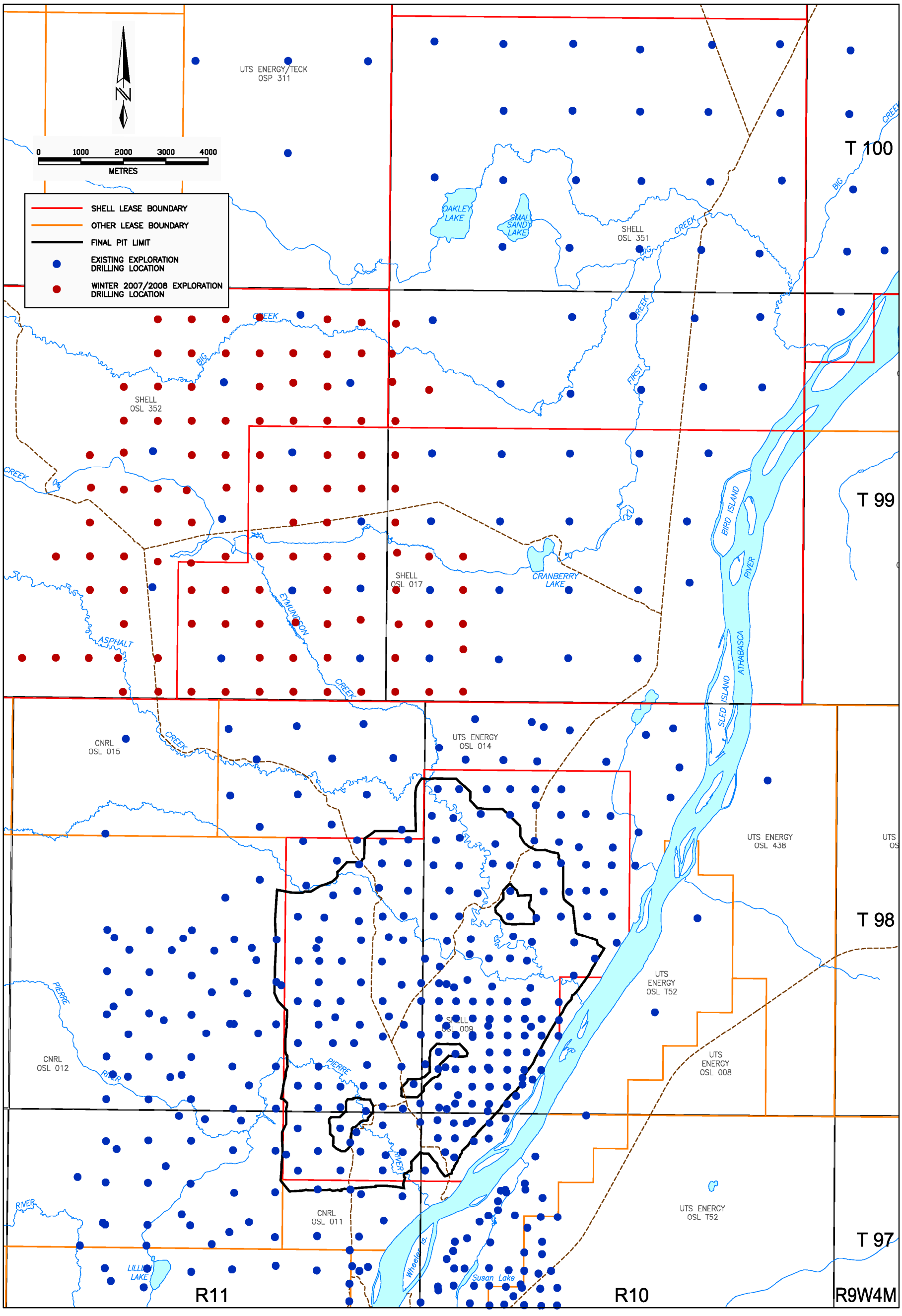


Figure 4-1: Exploration Drilling Density

FINES DATA

The fines definition (material with grain size less than 44 μm) is mainly important for assessing the performance of ore processing, tailings and waste disposal. Typically, the percentage of fines depends on the quantity of muddy facies that cannot be separated from the ore facies, or on the quantity of waste facies that must be excavated to access ore facies.

Since February 2002, data on particle size distribution has been obtained using a Mastersizer 2000 laser diffraction-based system. The laser diffraction technique is stable and has a high level of repeatability. The instrument used has a useful range between 0.02 and 2,000 μm, with output divided into 100 increments in an exponential relationship. After each sample is prepared, results are based on 120,000 readings taken over two minutes.

The laser diffraction method allows for grain size sampling continuously down the well. The particle size distribution samples will be broken at facies boundaries, with no sample exceeding an increment of 3 m. If a facies interval is more than the 3 m maximum, the facies is sampled more than once. The fines characterization of the Pierre River Mine area is at an early stage. Fifty-seven of the wells drilled in 2006 have already been analyzed, resulting in more than 1,300 particle size distribution determinations. Select wells drilled in 2007 will also be included in the database when their particle size distribution has been determined.

GEOLOGICAL DATABASE

Data Quality

Data quality is dependent on:

- competent drilling with minimal core loss
- accurate sample collection and analysis
- proper transcription of results
- precise surveying of well locations
- successful archiving and retrieval of accumulated data

The first resource assessment of Lease 9 was made using a database of 162 wells, on and around Lease 9, provided by Norwest Corporation. Included were all the wells drilled in and before 1982 that were thought to be useful for ore delineation. About 90% of these wells provided a complete intersection of the McMurray Formation, starting in the overburden above and ending in the Devonian limestone below. The remaining 10% intersect all ore zones, if any, and end in the watersand.

The database received from Norwest Corporation is electronic and was used by them to create a block model in Medsystem/Minesight. Hard copy files also exist, mostly of the 1982 wells that were held by Petro-Canada, which was the leaseholder before the leases were allowed to lapse. The lease was re-issued in a

slightly different conformation to Encana in 2000, before being acquired from Encana by Shell in 2004.

The wells drilled by Shell in 2006 and 2007 both infill and expand the pattern of previous drilling. In 2006, the well locations reduced the between-well spacing from 1,000 m to 600 or 700 m west and north of the Pierre River Mine area where the 1957 drilling established the core of the resource. Additionally, about 25 wells were located in about eight sections to the north in Lease 9, essentially beyond the area of existing drilling. In 2007, drilling concentrated on infilling between the 2006 wells at the north end of Lease 9, and bringing the spacing down from 800 to 600 m.

Every recent well was geophysically logged using wireline tools. Historically, Shell devoted considerable effort to defining and refining a series of continuously improving algorithms, which are used to predict bitumen grade through reference to various logs.

A computerized routine is used to calculate a total volume to bitumen in place (TV/BIP) value at the well location from the simulated bitumen grades. The routine uses only ore intervals greater than 3 m thick, with an average grade of greater than 7%, and is run iteratively with a graduated TV/BIP cut-off of 12, 18 and 300. This provides an indication of the resource potential in an area as soon as the Log ASCII Standard (LAS) file is received from the field.

Block Model

A computer model operates most effectively when the input data includes continuous records of bitumen grade assays for cores of each well. For the Pierre River Mine model, the bitumen value for lost core segments less than 0.5 m was approximated using an average of the bitumen value above the missing interval, and the bitumen value below. For anything larger than 0.5 m, the resistivity log was consulted to make sure an appropriate value was inserted. A standard part of the geological description process is to tabulate the estimated ore grade for new core, then compare that number with the Dean & Stark results. Therefore, routine estimates of bitumen grade for missing intervals can be made with confidence.

Model Structure and Parameters

Maptek Proprietary Limited's Vulcan is a multi-modular suite of computer modelling software widely used in the mining industry. This software was used to calculate the bitumen resource for the project development area.

A Vulcan model is built by establishing a 3-D structural framework that will ultimately contain all the wells. The area to be mapped dictates the size of this framework in the X and Y directions. The Z dimension must encompass the collar elevation of the hole that is drilled at the highest elevation, and the total depth of the hole that penetrates to the lowest elevation. The block model for the Pierre River Mine area has block dimensions of 100 m in the X and Y directions, and is 1 m in the Z direction. Enough variables were defined within each block for all the values to be interpolated into the block from raw data, or calculated

Model Structure and Parameters (cont'd)

after the interpolation was complete. Each of these block models draws from the same database that is set up to contain the raw drill hole data, including:

- header (hole location, elevation and depth)
- member (stratigraphic data, which may also include facies)
- assay (the Dean & Stark analyses and related calculations)

The block modelling procedure in Vulcan requires that a composite file be built from the well database to produce a single file with all the well data in it. This is done before individual assay values from the well are assigned into a block. In this case, a natural interval composite file was used, where the composite intervals were the same as the assay intervals.

An inverse distance squared function is used to load each block in the model from the composite well data. The search ellipse is the maximum distance from which the values in the block can be influenced by well data. For each model, the radius of the search ellipse was 1,500 m in the X and Y direction and 10 m in the Z direction. This guaranteed complete coverage between the wells, but also lowered the average grade.

Whenever a large interpolation radius is allowed, the algorithm includes a large number of background values from distant wells, in addition to the more relevant values from the few wells near the target block. As more closely spaced wells in the resource areas allow a shorter radius of interpolation, the ratio of background values used to neighbouring values will decreases, and the average grade reported from the block model increases.

The background effect was moderated by the other modelling parameters influencing the block model. The minimum number of samples required to determine the value of a block was two and the maximum was six. An octant search was used (splitting the ellipse of influence into eight equal sectors, four above the Z plane and four below), with a maximum of two samples per octant.

The Pierre River Mine model has a single ore zone. Therefore, the confining surfaces used are:

- topography
- base of overburden (top of the McMurray) – no ore occurs in the Pleistocene
- Devonian – any grade values appearing below this horizon are assigned a value of zero

The surfaces are prioritized from the bottom up. Where any two surfaces intersect, the lower surface overrides the upper.

Over 200 non-Shell wells were included in the model, in the area up to 5 km outside Lease 9, to eliminate edge effect or the distortion of extrapolation toward the edge of the lease.

TV/BIP

TV/BIP has generally been used to determine the mine pit outline. This is prepared from a block model by deriving an individual number for the total volume of a column of blocks to the base of the orebody, and dividing it by the volume of bitumen it contains. The EUB Interim Directive 2001-07, *Operating Criteria: Resource Recovery Requirements for Oil Sands Mine and Processing Plant Sites,* specifies a minimum mineable thickness of 3 m with a 7% bitumen grade. The TV/BIP calculation allows the following to be set:

- TV/BIP cut-off ratio
- oil sands density
- bitumen density

Wherever possible, the TV/BIP calculation provides for the assembly of groups of adjacent blocks from each vertical column with an aggregate average grade of 7% or higher. Three or more continuous blocks constitute an ore zone. The average grade of each ore zone is stored in a variable called *compore*, and an integer for the number of the ore zone, increasing downward, is stored in a variable called *compint*. The TV/BIP calculation creates a point with three-dimensional coordinates at the base of the lowest ore zone within the specific TV/BIP cut-off ratio.

If the TV/BIP cut-off is set to a value greater than 12, the floor of the lowest ore zone could be set at a lower elevation. Relaxing the TV/BIP requirements results in an additional ore zone being included beneath what is allowable, with a total volume in place less than the 12 (TV/BIP 12) cut-off. This means that a total area TV/BIP map cannot be prepared with constant parameters. The TV/BIP map, (see Figure 4-2), was prepared by first limiting the cut-off to 12, then increasing it to 300. The following types of maps were prepared using a similar blending of two runs of the TV/BIP calculation at different cut-offs:

- total ore and waste thickness (see Figure 4-3)
- mineable ore thickness (see Figure 4-4)
- average in situ ore grade (see Figure 4-5)

Ore Thickness

The ore thickness map generated by the block model has been augmented by the drilling results from Leases 17, 309, 310, 351 and 352. Drilling from these leases, with well centres spaced at 1,600 m to 3,200 m, generates data that is too sparse to support a meaningful block model, but the general trend of ore distribution is clearly defined. There is no ore currently defined in the east half of Leases 17, 351 and 310, and no ore currently defined in the whole of Lease 309.

Ore Thickness (cont'd)

The minimum mineable ore thickness contour is drawn at 3 m, according to EUB Interim Directive 2001-07. The position of the external tailings disposal area (ETDA) is also shown, and generally does not overlie any mineable ore.

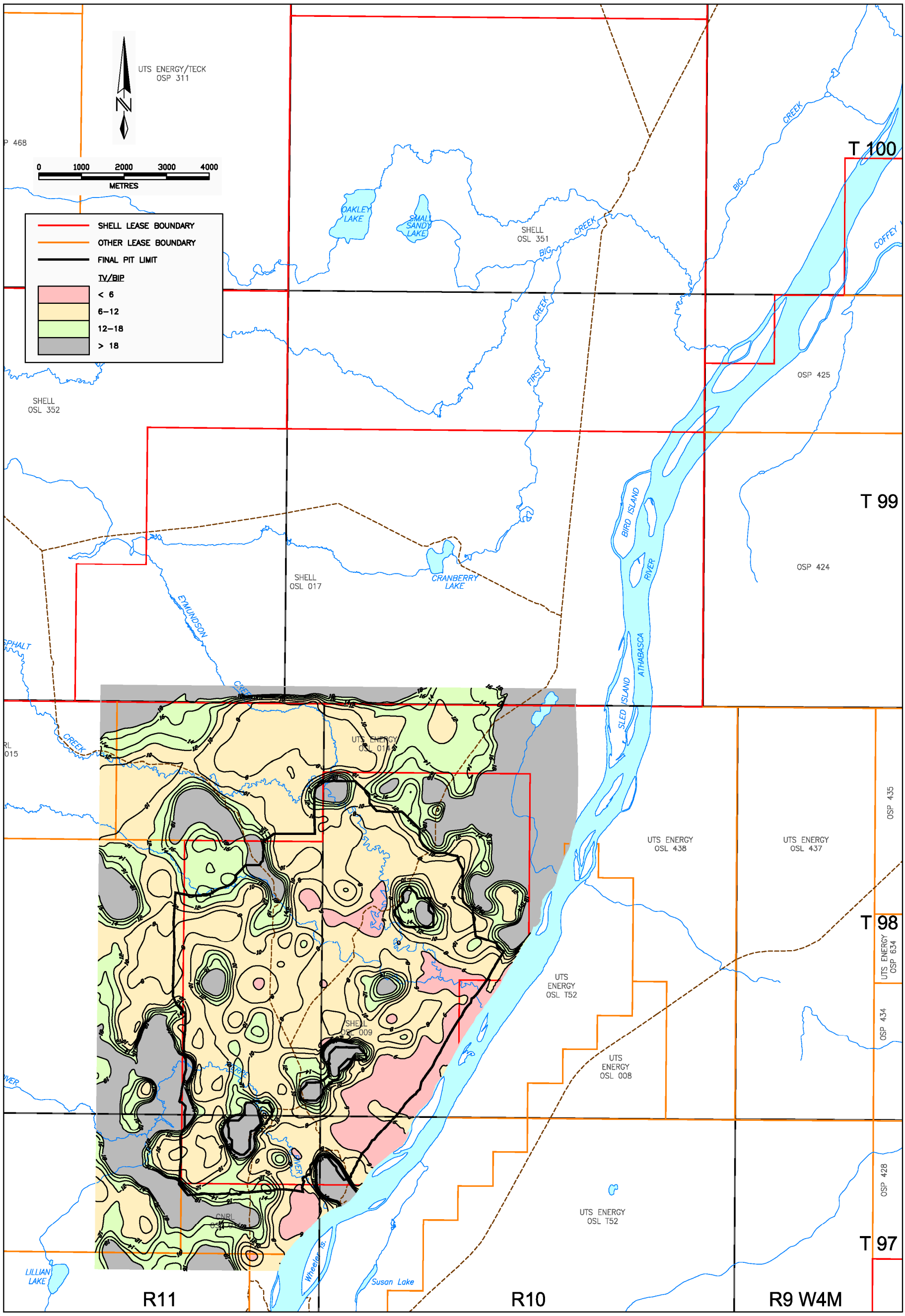


Figure 4-2: TV/BIP Map of the Pierre River Mine Area

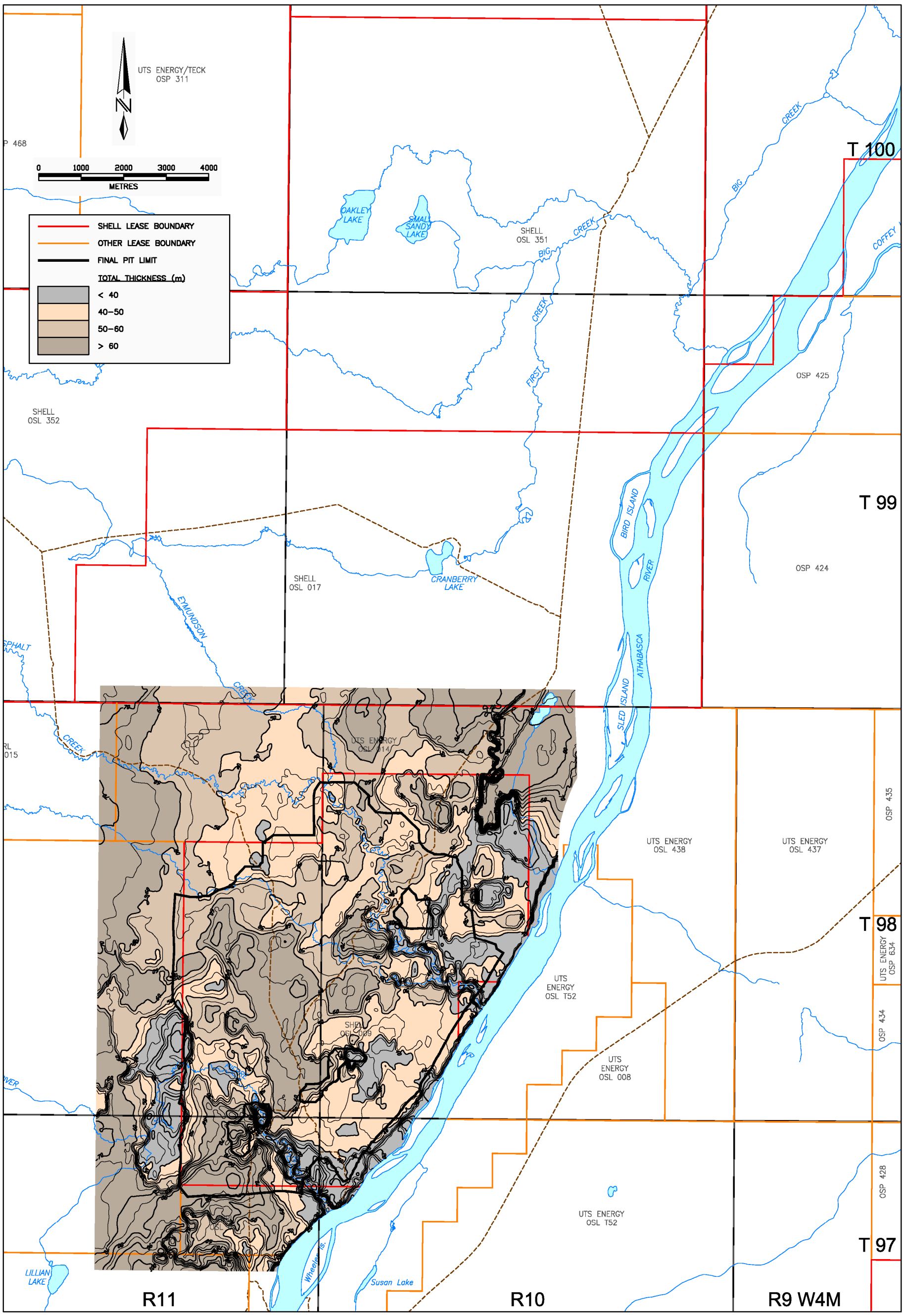


Figure 4-3: Total Ore and Waste Thickness in the Pierre River Mine Area

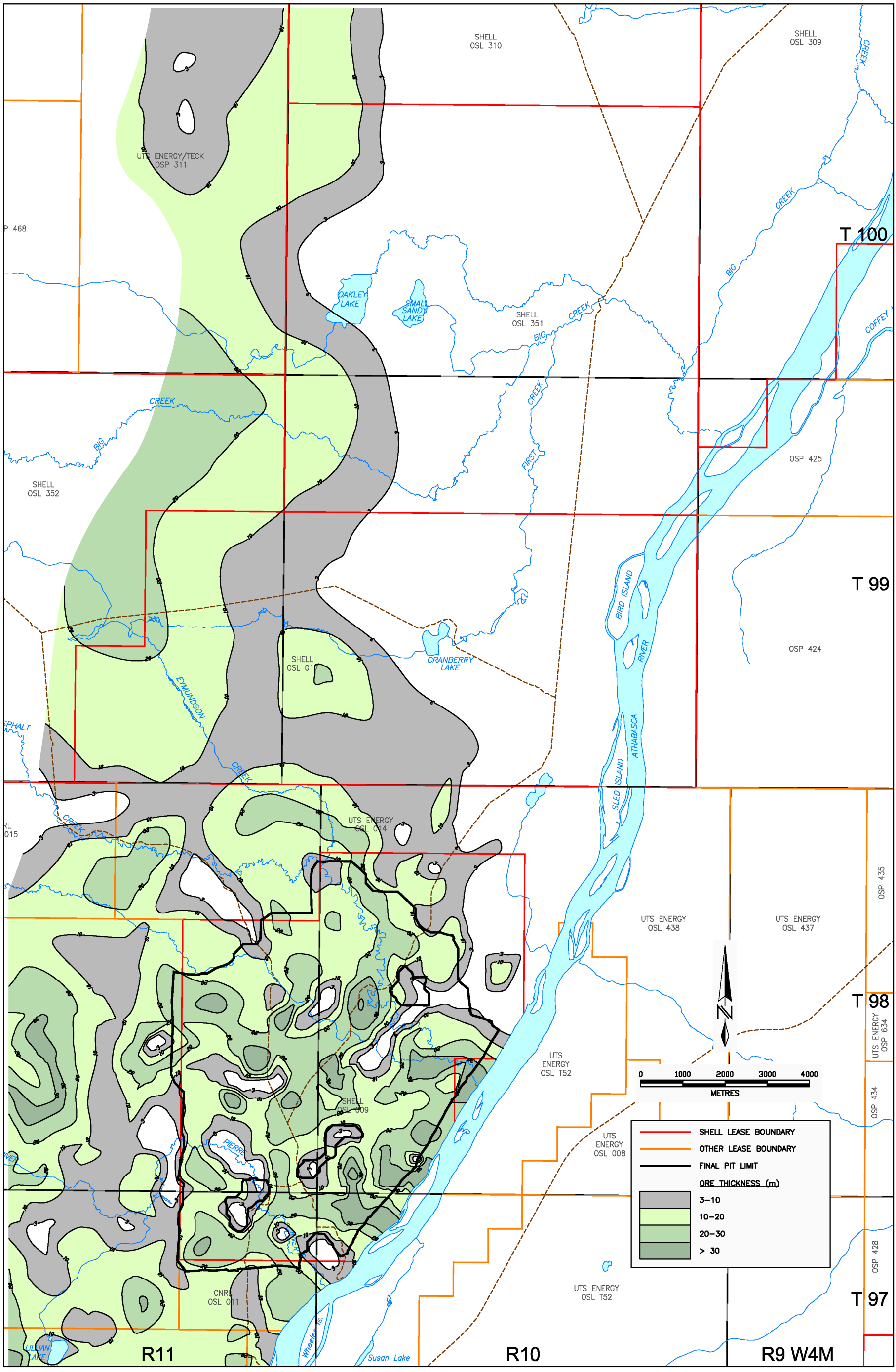


Figure 4-4: Mineable Ore Thickness in the Pierre River Mine Area

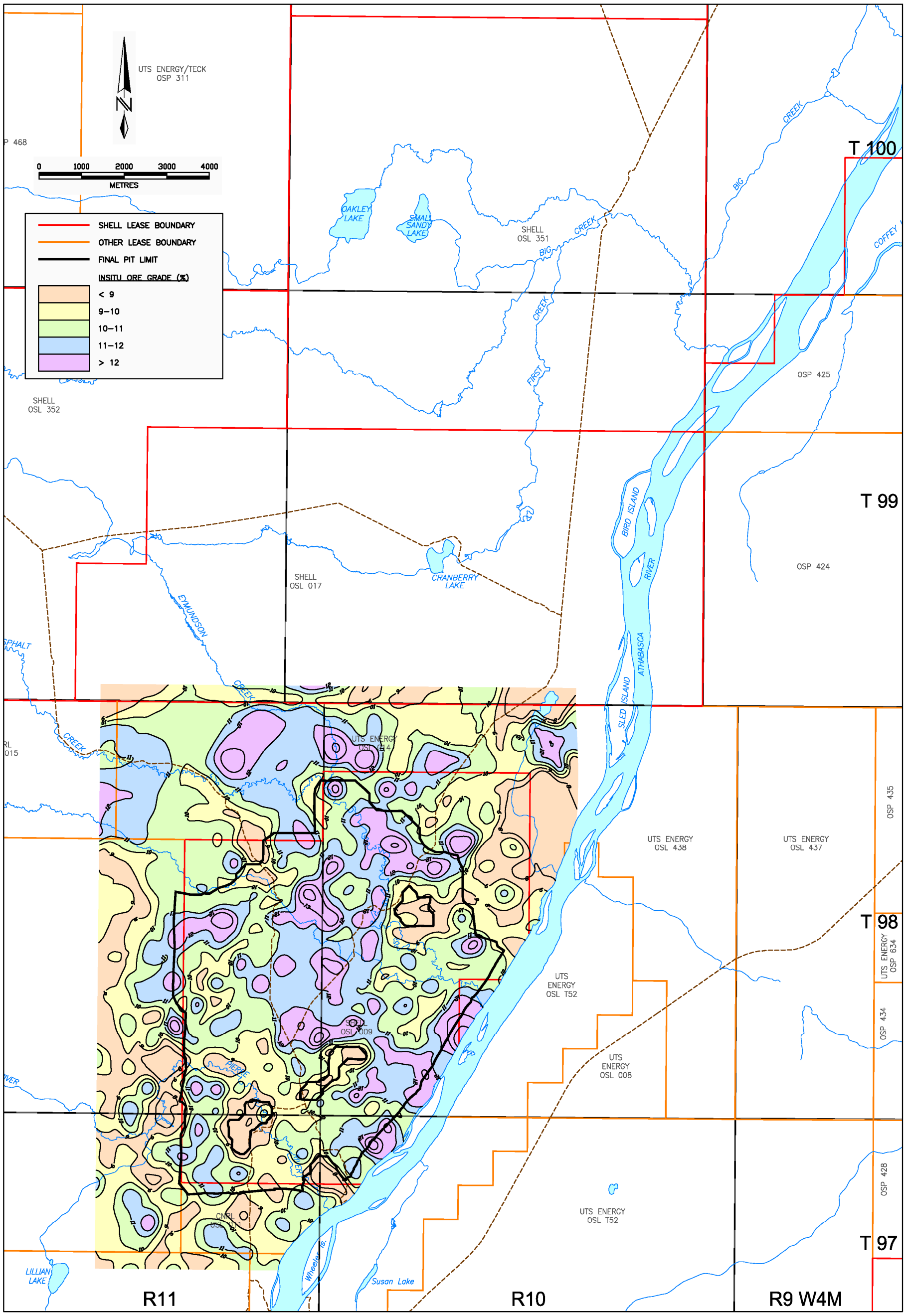


Figure 4-5: Average In Situ Ore Grade in the Pierre River Mine Area

BLOCK MODEL BOUNDARIES

The block model used to calculate the bitumen resource for the Pierre River Mine area is a square, spanning 15 km in both X and Y dimensions, and 280 m along the Z-axis.

BLOCK MODEL VOLUMES

The total resource volume calculated for the Pierre River Mine area of the leases, which define the property boundary and pit area, is calculated within the following categories:

- total in situ bitumen resource
- ore with greater than 7% average bitumen grade at a minimum thickness of 3 m
- ore with TV/BIP 12

TOTAL IN SITU RESOURCE

The total in situ resource includes all resources in the modelled area of Lease 9 without applying a minimum cut-off grade (see Table 4-2).

Table 4-2: Lease 9 Resource Summary

Resource Category	Lease 9 Area				Lease 9 Pit Area			
	Volume of Ore (Mm^3)	Grade (%)	Bitumen (Mm^3)	Bitumen (Million bbl)	Volume of Ore (Mm^3)	Grade (%)	Bitumen (Mm^3)	Bitumen (Million bbl)
Total In situ resource	11,226	1.37	318	2,002	11,179	1.34	310	1,949
Ore at >7% average bitumen grade and minimum 3 m thickness	1,182	11.14	272	1,711	1,144	11.05	261	1,642
Ore at TV/BIP <12	1,141	11.18	264	1,658	1,170	11.05	267	1,680

GRADE DISTRIBUTION

Figure 4-6 shows the bitumen grade distribution curve for ore at TV/BIP 12 within the Pierre River pit. The weight percent (wt%) bitumen increases in increments of 0.5%.

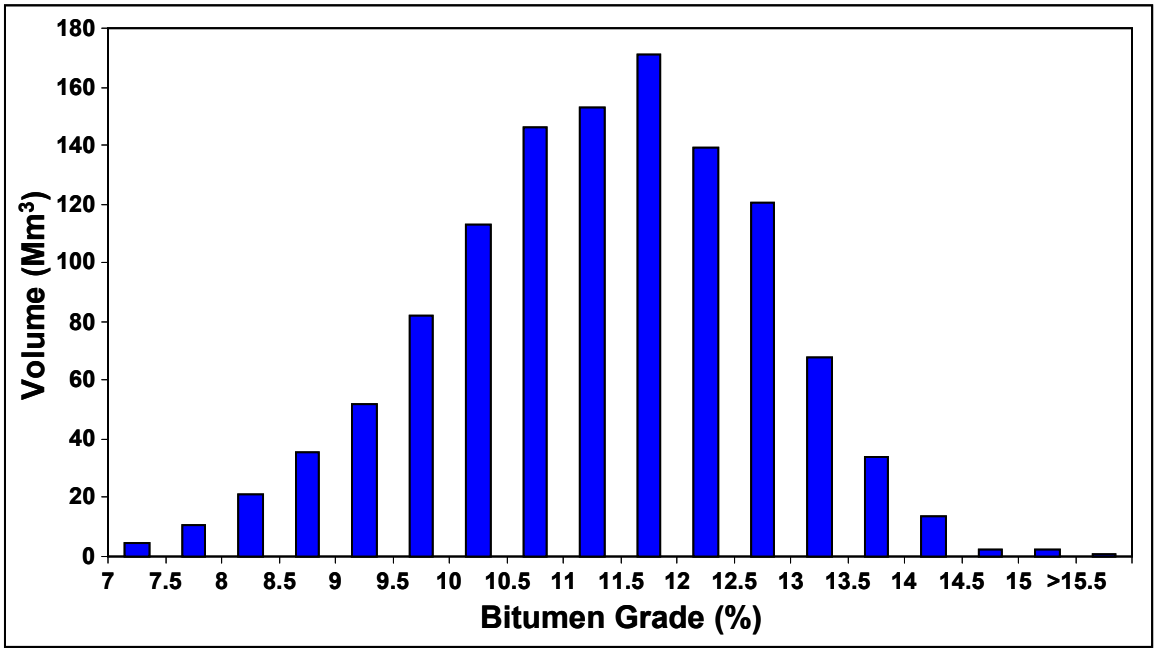


Figure 4-6: Pierre River Mine Cumulative Grade Distribution Curve

ORE OVER 7% AVERAGE BITUMEN GRADE AND MINIMUM 3 M THICKNESS

To be classified as ore, the average grade of a continuous 3 m (or greater) thickness must be at least 7%. Applying the minimum mineable criteria with the TV/BIP calculation considers the greater than 7% average grade and less than 7% average grade material in 3 m segments down the well. The 3 m value is the minimum separable thickness, taking into account the mining equipment to be used.

ORE AT TV/BIP 12

The TV/BIP 12 limit largely defines the mine area, although some TV/BIP 12 exists outside the pit. Ore grade is an element of the TV/BIP calculation, so the TV/BIP 12 limit preferentially encompasses above-average grade material.

The TV/BIP calculation, in the process of flagging the ore and waste zones, makes possible the separation of top reject, or mine overburden, from mine interburden. All waste from above the first ore zone is classified as overburden, or depth to top of ore, and is shown in Figure 4-7. Because the ore in the Pierre River Mine area occurs predominantly in a single ore zone, no interburden occurs.

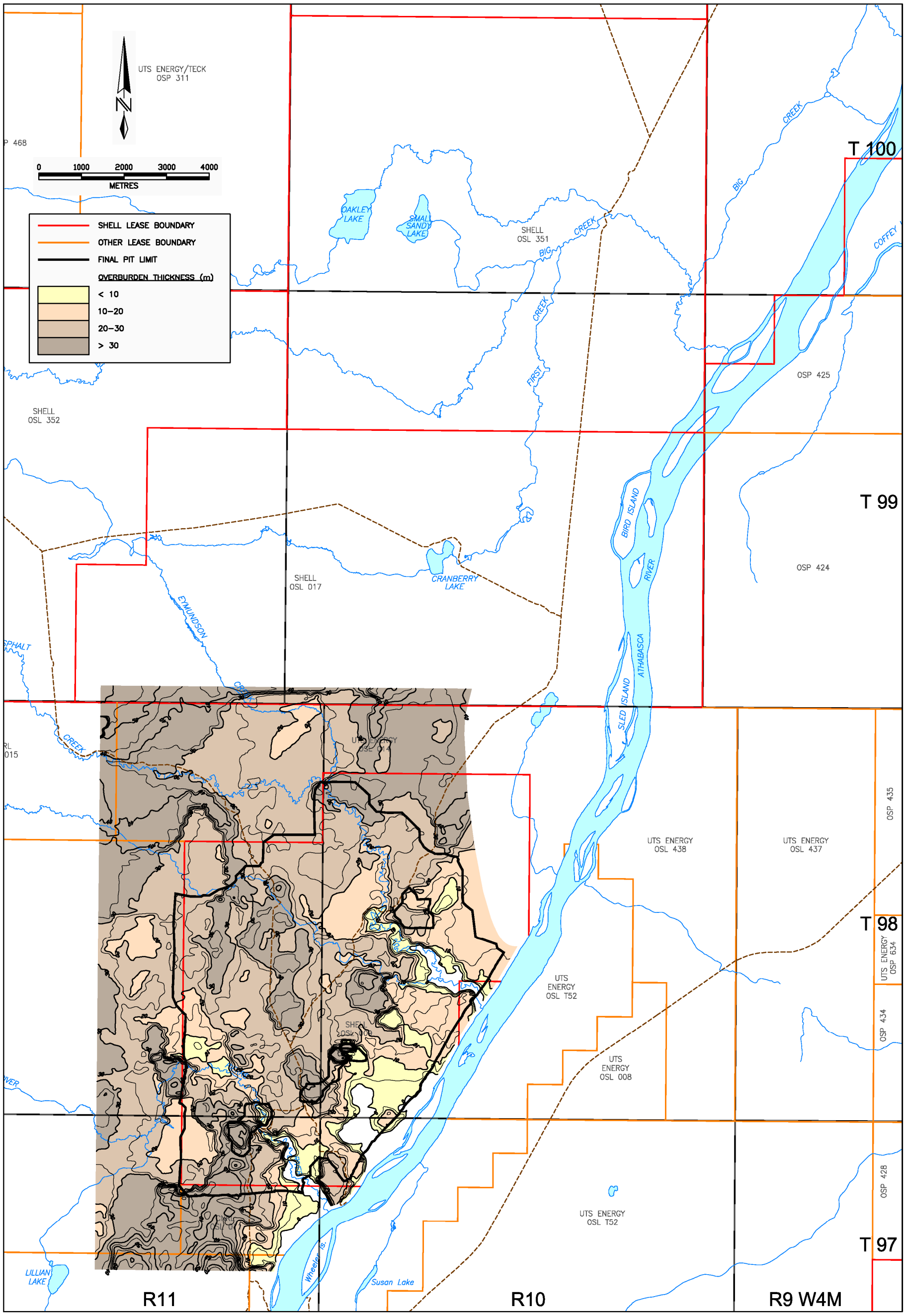


Figure 4-7: Overburden Thickness

ORE AT TV/BIP 12 (cont'd)

The pit volumes calculated for in situ bitumen, and ore with the mineability cut-offs applied, are derived from a polygon set right along the lease boundary with vertical sides. The pit shell calculation for ore at TV/BIP 12 starts from the same polygon and incorporates sloped and benched sides. Thus, this volume is slightly larger as it includes some bitumen from neighbouring leases.

PROJECT DEVELOPMENT AREA RESOURCE

Figure 4-8 shows the locations of the geological cross-sections in relation to the project development area. Most cross-sections are oriented east–west at about 1 km intervals.

The cross-sections are illustrated in:

- Figure 4-9 – Cross-Section A–A′
- Figure 4-10 – Cross-Section B–B′
- Figure 4-11 – Cross-Section C–C′
- Figure 4-12 – Cross-Section D–D′
- Figure 4-13 – Cross-Section E–E′
- Figure 4-14 – Cross-Section F–F′

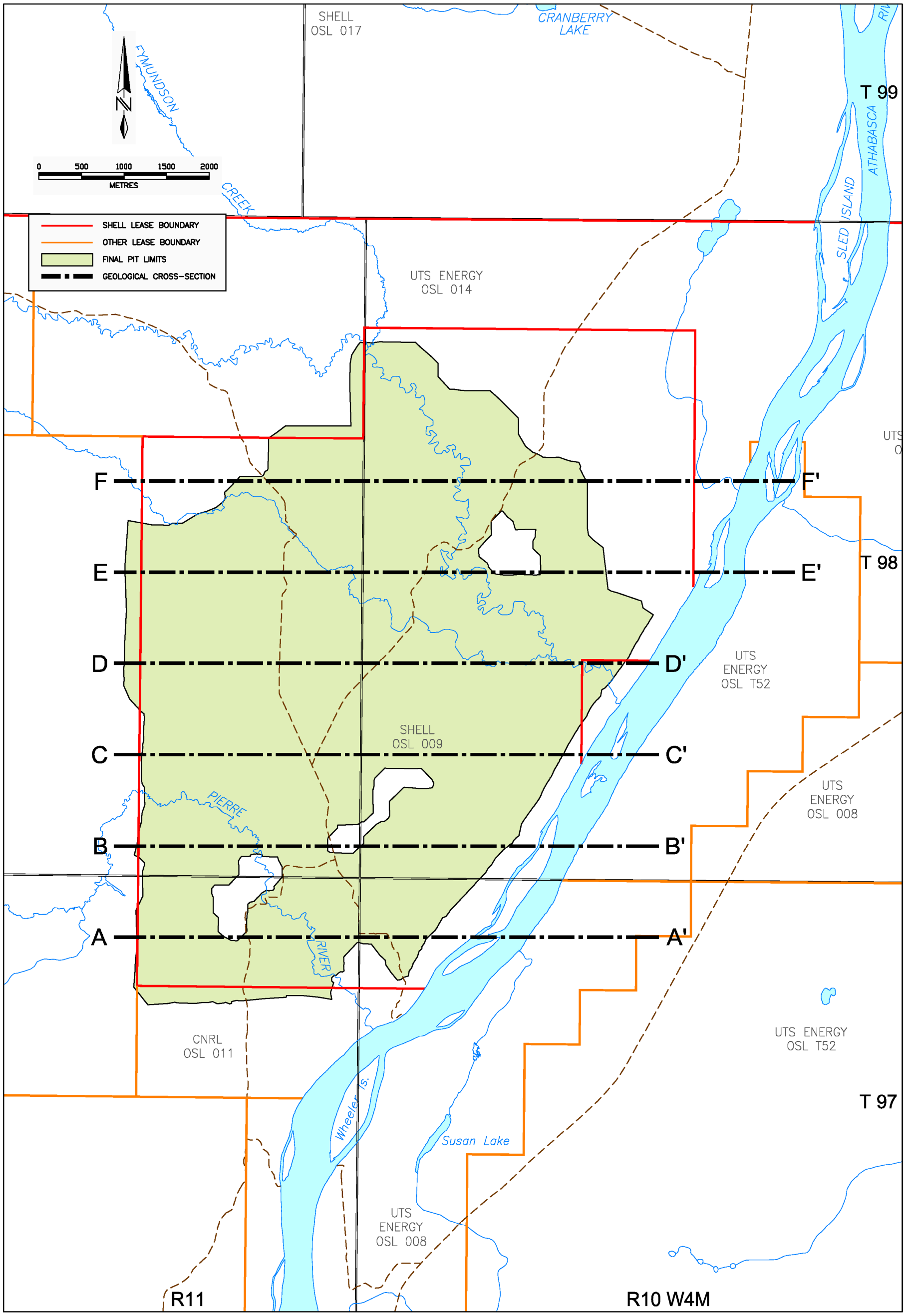


Figure 4-8: Cross-Section Locations in the Pierre Mine Expansion Area

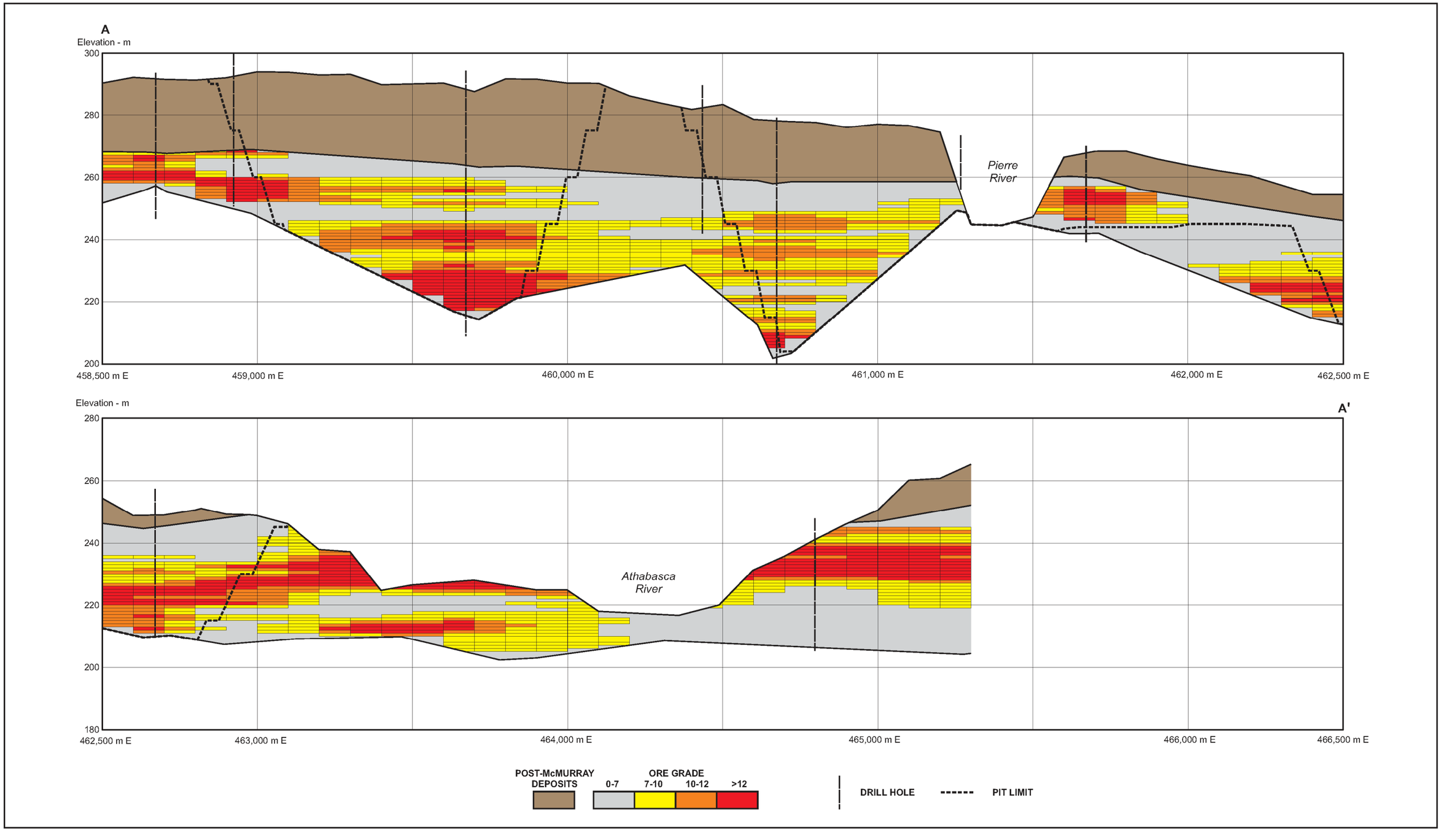


Figure 4-9: Cross-Section A–A′

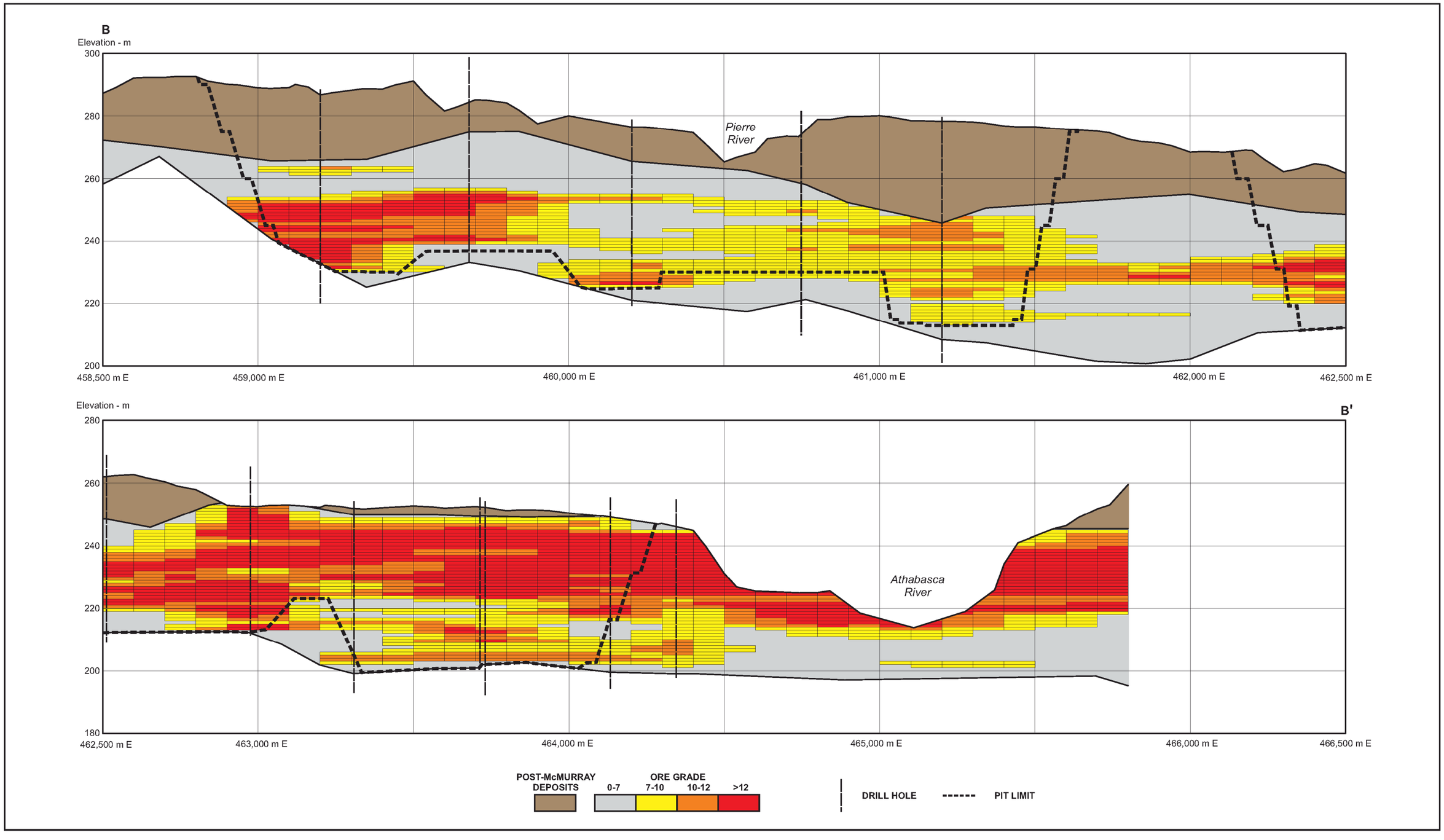


Figure 4-10: Cross-Section B–B′

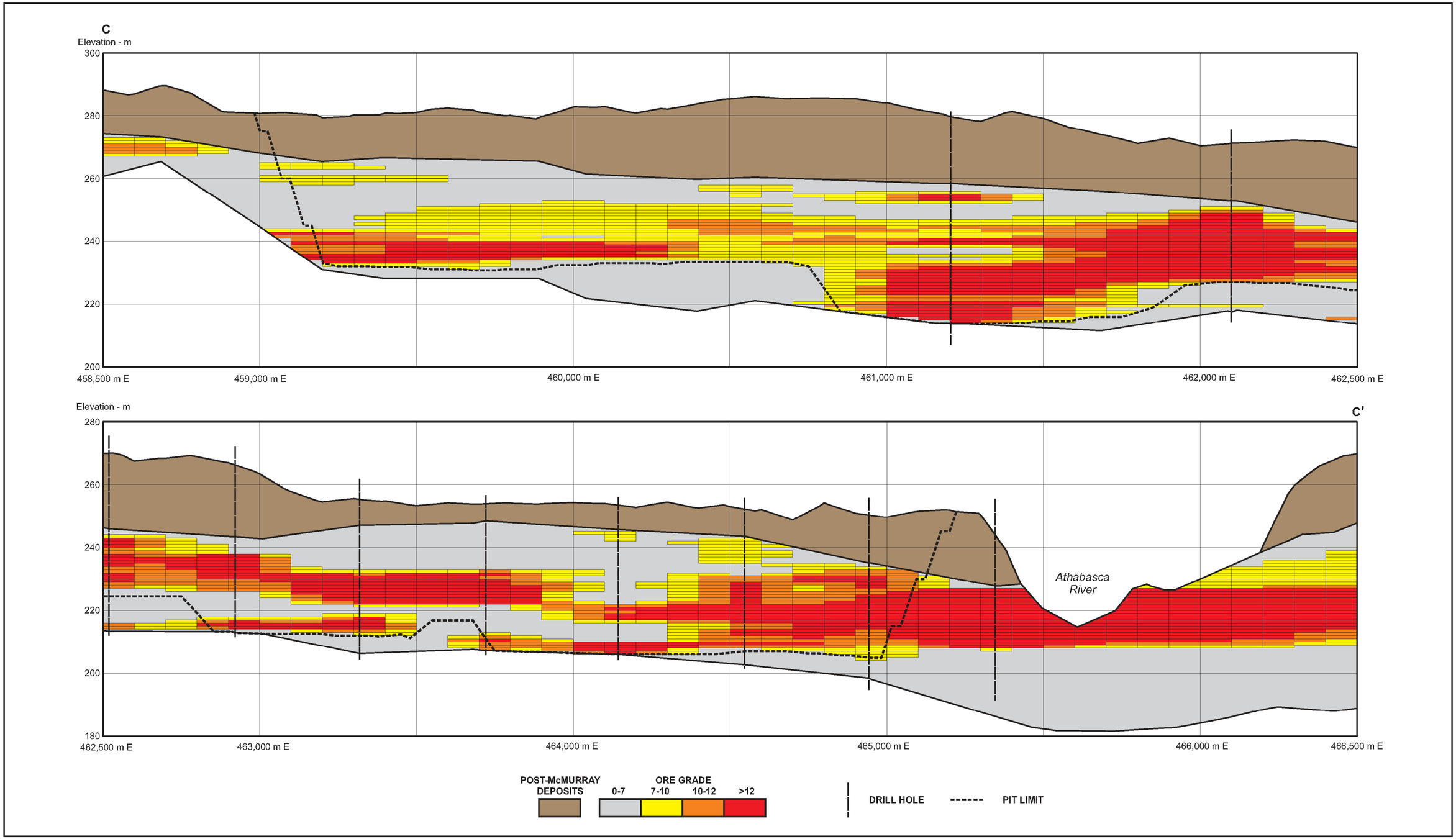


Figure 4-11: Cross-Section C–C′

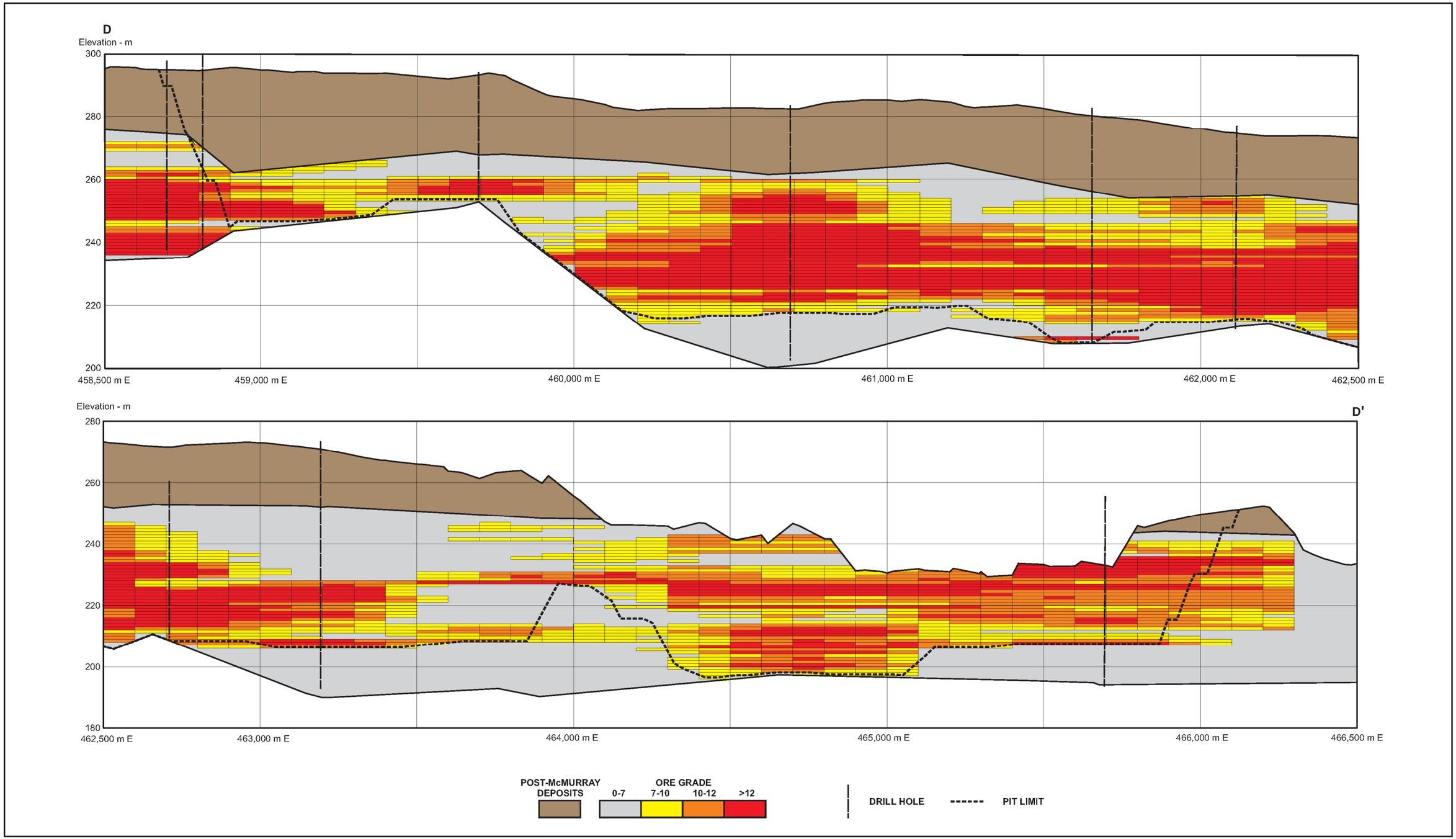


Figure 4-12: Cross-Section D–D′

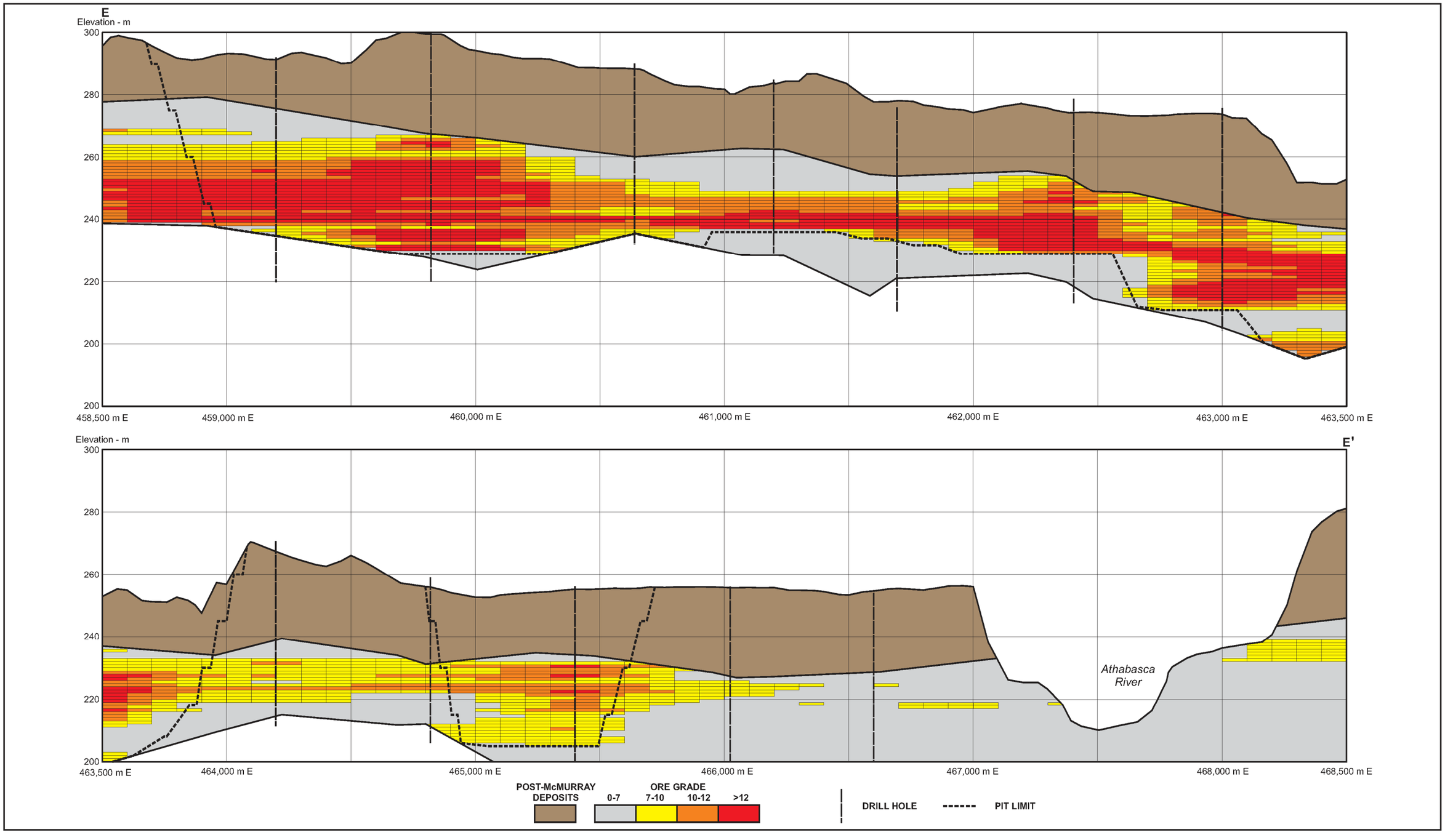


Figure 4-13: Cross-Section E–E′

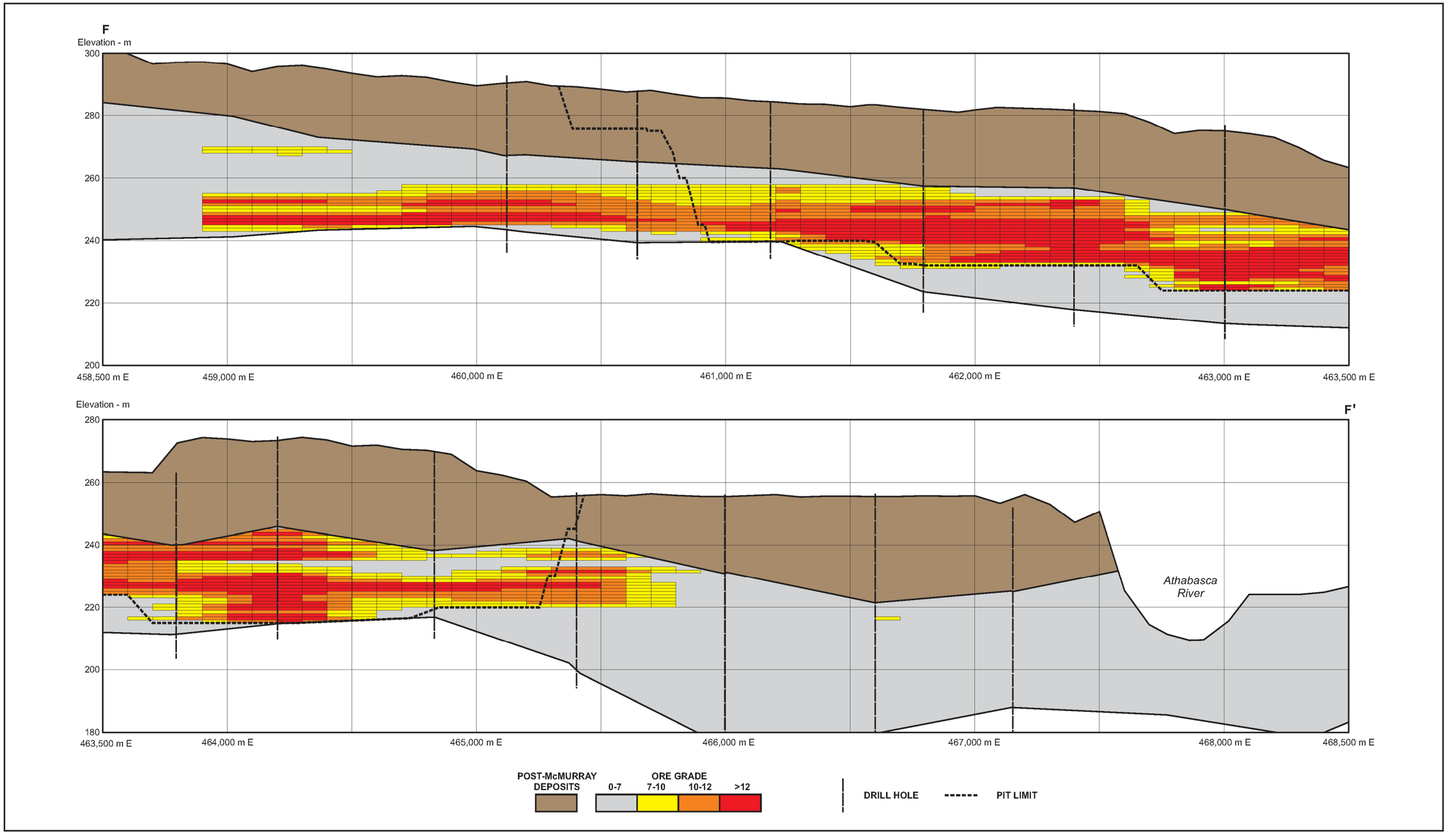


Figure 4-14: Cross-Section F–F′

MINING METHOD

The mine plan for the Pierre River Mine is based on the truck-and-shovel mining system, with a relocatable ore crusher station, similar to that currently used at the Muskeg River Mine and approved for the Jackpine Mine – Phase 1.

In 2019, the first full year of mine operation for the Pierre River Mine, 20 Mt of ore and 36 Mbcm of waste will be moved using:

- four cable shovels
- 20 363-t haul trucks
- associated support equipment

The Pierre River Mine fleet will require an additional 24 trucks and four shovels to meet the ore capacity requirements, and to remove additional waste material as the mine progresses through higher waste-to-ore ratio areas.

The mine plan for the Pierre River Mine was developed for an average recovered bitumen production rate of 11 Mm^3/a, or 30,000 m^3/cd (188,890 bbl/cd). The mine plan will support two processing trains, each with a nominal capacity of 15,900 m^3/cd (100,000 bbl/cd). A total of 2,349 Mt of oil sands will be mined and 207 Mm^3 of bitumen recovered during the life of the mining operation.

MINING RESOURCES

The Pierre River mine is located on the west side of the Athabasca River. The proposed mining area at the Pierre River Mine is primarily on oil sands Lease 9. The area is bound on the south and west by Leases 11 and 12, which are held by Canadian Natural Resources Limited (CNRL), and to the north by Lease 14, which is held by UTS Energy Limited (UTS).

The known mineable resource at the Pierre River Mine is about 207 Mm^3 of dry bitumen product. The mineable resource will support an operating life of about 22 years for two processing trains.

Before mining along adjacent oil sands leases containing mineable resources, joint planning discussions will be held with adjoining leaseholders. The discussions will identify specific alternatives to effectively manage the resources along the Pierre River Mine boundaries. Table 5-1 lists the characteristics of the Pierre River Mine area.

Table 5-1: Pierre River Mine Expansion Project Pit Attributes and Area

Pit Attribute	Total
Mine pit area	5,016 ha
Bitumen in place (BIP)	261 Mm^3
Diluted ore grade	10.9 wt% bitumen
Final bitumen product	207 Mm^3
Ore	2,349 Mt
Waste (including muskeg)	1,092 Mbcm
Strip ratio	0.97 bcm/bcm
TV/BIP	8.5 bcm/m^3

OBJECTIVES

The overall mining objective is to provide the lowest cost mine plan that maximizes resource recovery from the Pierre River Mine and meets the needs of mining, bitumen extraction and tailings management. The specific objectives of the mine plan are to:

- optimize ore recovery
- provide reliable oil sands feed to the processing plant, at a consistent grade and a constant and controllable feed rate
- provide for progressive reclamation
- provide an acceptable mine closure plan
- strategically locate the overburden and interburden disposal areas in non-economic zones

RESOURCE EVALUATION

Evaluation results are provided in the following:

- Table 5-2, which shows the Pierre River Mine pit evaluation results
- Figure 5-1, which shows the areas that were evaluated for the Pierre River Mine

After modelling the pit limits, islands of non-economic resource were identified. Islands greater than 12:1 TV/BIP within the Pierre River Mine final pit limits were generally excluded from the resource base.

FINAL PIT LIMIT DEFINITION

The Pierre River Mine final mine pit comprises a total area of about 5,016 ha (see Figure 5-2). The circumference of the pit is defined primarily by 12:1 TV/BIP, except where the pit was limited by lease boundaries or was offset from the Athabasca River.

Table 5-2: Pierre River Mine Pit Evaluation Results

Area	Ore (Mt)	Overburden and Interburden (Mm^3)	Diluted Ore Grade (wt% bitumen)	Bitumen in Place (Mm^3)	TV/BIP	Strip Ratio (bcm/bcm)
Island 1	37	24	9.1	3.4	12.4	1.38
Island 2	35	31	9.6	3.3	14.6	1.85
Island 3	42	40	9.4	3.6	16.5	1.97
Island 4 *	62	35	10.8	6.7	9.6	1.17
Island 5 *	45	30	11.0	5.0	10.4	1.38
Island 6 *	30	23	10.4	3.1	11.8	1.57
Note *: Island was included in the mining resource for operational or economic reasons.						

PIERRE RIVER MINE PIT LIMITS

Segment 1 to 2

Segment 1 to 2 is defined by the 12:1 TV/BIP limit. Multiple drill holes define the large area with greater than 12:1 TV/BIP where the extraction plant and ore preparation facilities and north waste dump will be located. A small lobe of TV/BIP less than 12, defined by a single drill hole, will not be mined in this segment.

Segment 2 to 3

Segment 2 to 3 is defined by setbacks from the Athabasca River. The mineable orebody of TV/BIP less than 12:1 extends east under the Athabasca River along the entire eastern boundary of the Pierre River Mine area. Shell recognizes the environmental benefit of preserving the Athabasca River, the river valley ecosystems and the wildlife connectivity along the valley. Therefore, Shell will leave a mining setback of at least 250 m from the high water line on the western shore of the Athabasca River. The minimum setback defines about 6.54 km of pit boundary.

Segment 3 to 4

The 12:1 TV/BIP limit defines Segment 3 to 4. One drill hole defines the area with TV/BIP greater than 12:1.

Segment 4 to 5

The boundary with CNRL's Lease 11 defines Segment 4 to 5. Based on its publicly disclosed mine plans, CNRL's Horizon Mine operations do not mine to the lease boundary. The Pierre River Mine will remove ore to the mid-ore elevation along the Lease 11 boundary.

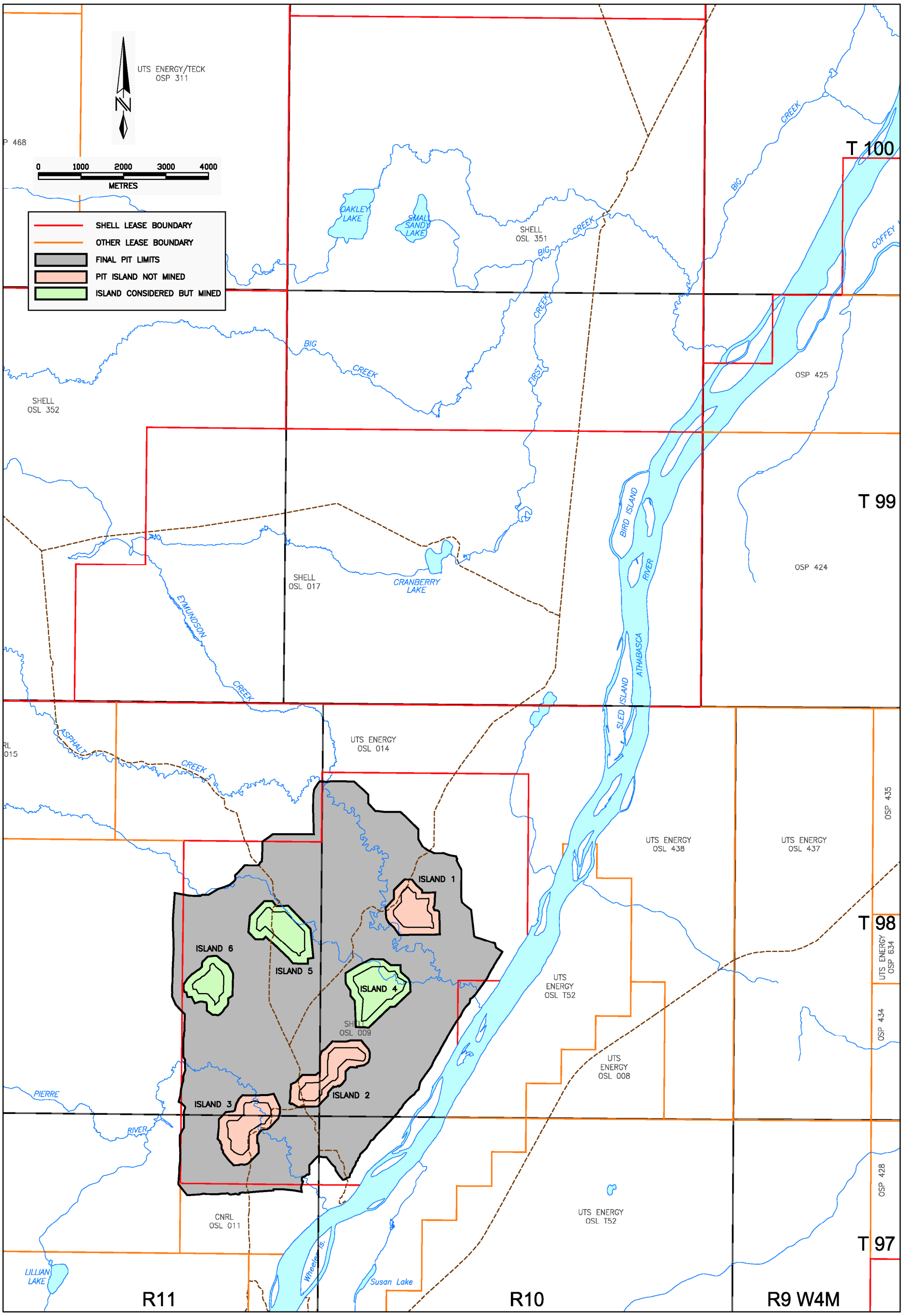


Figure 5-1: Pierre River Mine Pit and Island Evaluation

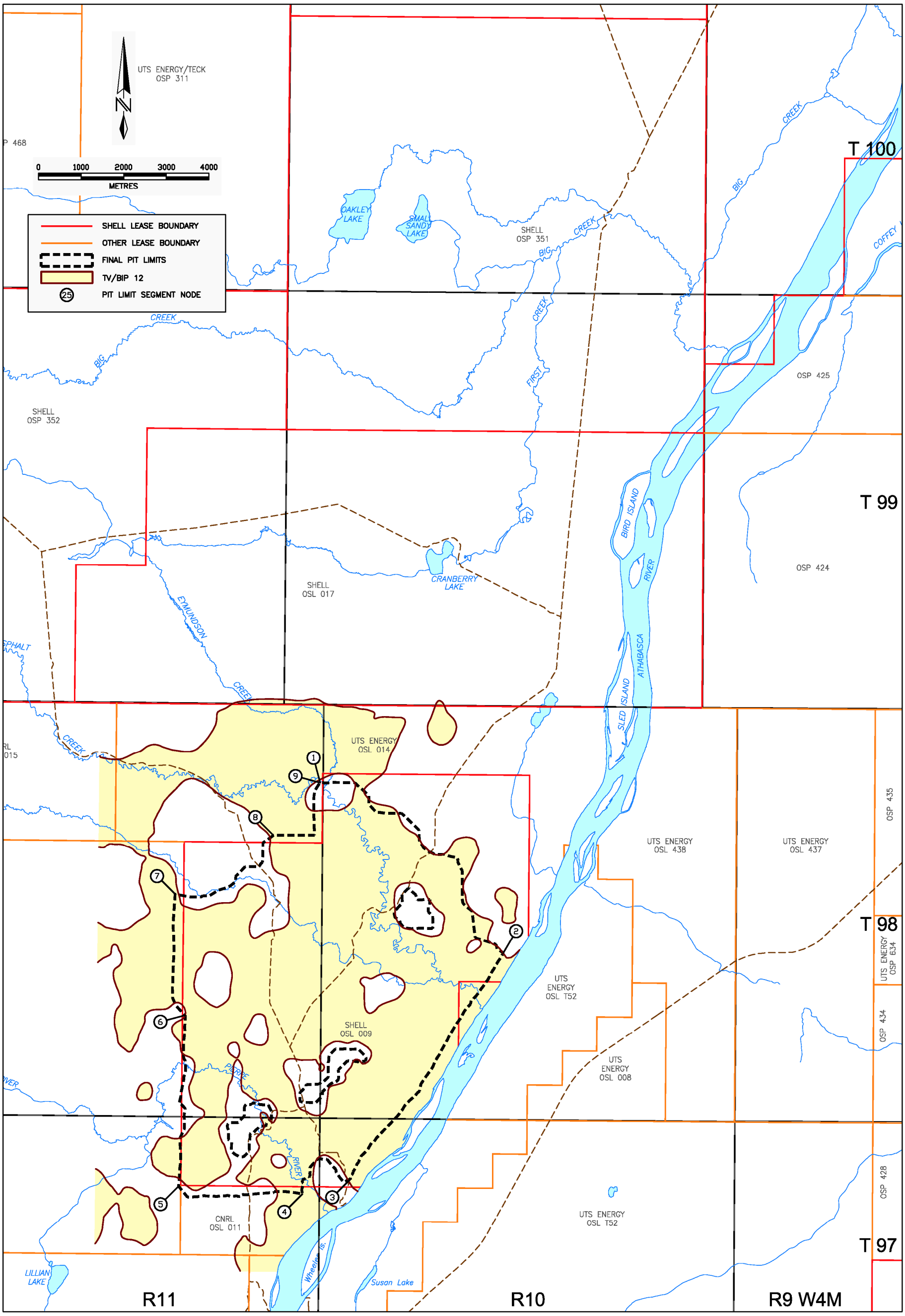


Figure 5-2: Pierre River Mine Final Pit Limits

Segment 5 to 6

The 12:1 TV/BIP limit defines Segment 5 to 6. Multiple drill holes define the large area with greater than 12:1 TV/BIP, which extends west through CNRL's Lease 12, based on Shell's current drilling data.

Segment 6 to 7

The boundary with CNRL's Lease 12 defines Segment 6 to 7. CNRL's Horizon Mine operations do not mine to the lease boundary. Based on Shell's drilling data, it is reasonable to assume that there is a recoverable resource to the west on CNRL Lease 12. Therefore, plans for the Pierre River Mine operations will remove ore to the mid-ore elevation along the Lease 12 boundary and construct a compacted fill barrier dyke.

Segment 7 to 8

The 12:1 TV/BIP limit defines Segment 7 to 8. Five drill holes on Shell's Lease 9 define the area with TV/BIP greater than 12:1. Shell's current drilling data indicates that the TV/BIP greater than 12:1 region extends north and west on adjacent leases.

Segment 8 to 9

The lease boundary with UTS Energy on Lease 14 defines Segment 8 to 9. Based on the publicly disclosed conceptual mine plan, mine operations on Lease 14 will reach this boundary first. The Pierre River Mine operations will remove ore to the mid-ore elevation along the Lease 14 boundary, and construct a compacted fill barrier dyke.

LOCATION OF SURFACE FACILITIES

Development of a new oil sands mine at the Pierre River Mine site will require placing the following major surface facilities:

- the process plant site and associated tank farm
- the external tailings disposal area (ETDA)
- the North overburden disposal area (OBDA)
- the raw water storage facility

The locations of the Pierre River Mine facilities have been selected to reduce or minimize:

- the environmental impact
- the sterilization of potentially economic ore

GEOTECHNICAL SETBACKS

Overburden Disposal Area

The setback distance from an overburden disposal area to a mining pit is site-specific, and requires a detailed geotechnical analysis at each location. The assessment for each site has included the:

- physical and geotechnical condition of the material in the disposal area
- geotechnical conditions of the subsurface strata
- hydrogeological conditions
- conditions of any potential advancing mine face

A setback of 150 m has been incorporated, based on industry practice and Shell's experience at the Muskeg River Mine.

External Tailings Disposal Areas

The Pierre River Mine ETDA is located north of the plant facility, partially on oil sands Leases 17 and 351. The ETDA is about 2 km from the Athabasca River and is positioned so that it does not sterilize or affect future potential mineable oil sands.

Plant Site

The plant site at the Pierre River Mine will be located in the northeast corner of Lease 9. The plant site is bound on the north and east by Lease 14 (which is held by UTS), by the north overburden dump to the west and by the pit crest to the south. The plant site is situated 100 m from the North OBDA, 200 m from the pit crest and 100 m from Lease 14.

Athabasca River

The Athabasca River bounds the entire east boundary of the Pierre River Mine pit. The Athabasca River valley rises 20 to 30 m from the river's edge to the crest of the valley. The minimum setback for the mine crest has been established at 250 m from the high water line of the Athabasca River.

RESOURCE STERILIZATION

Table 5-3 provides resource sterilization estimates for the Pierre River Mine and areas influenced by surface facilities and features. Figure 5-3 shows the locations of resource sterilization areas.

Table 5-3: Estimated Resource Sterilization

Areas	Ore (Mt)	Overburden and Interburden (Mbcm)	Diluted Ore Grade (wt% bitumen)	Bitumen in Place (Mm^3)	TV/BIP (bcm/m^3)	Strip Ratio (m^3/m^3)
North OBDA	0.00	0.00	N/A	0.00	N/A	N/A
ETDA	0.00	0.00	N/A	0.00	N/A	N/A
Plant area	3.89	2.06	9.85	0.39	10.01	1.10
Athabasca River setback	156.63	32.62	11.31	18.06	5.97	0.43
Total	**160.52**	**34.68**		**18.46**		
Weighted Average			**11.28**		**6.06**	**0.45**
Note: N/A = not applicable						

LOCATION OF OTHER FACILITIES

Corridors

The Pierre River Mine will be serviced by a main access corridor and a bitumen product pipeline corridor. The corridors will not sterilize the resources, as they will be situated on the plant site and not near the mining resource.

Reclamation Material Stockpiles

Reclamation material stockpiles will be removed as reclamation progresses, and will not sterilize the resource.

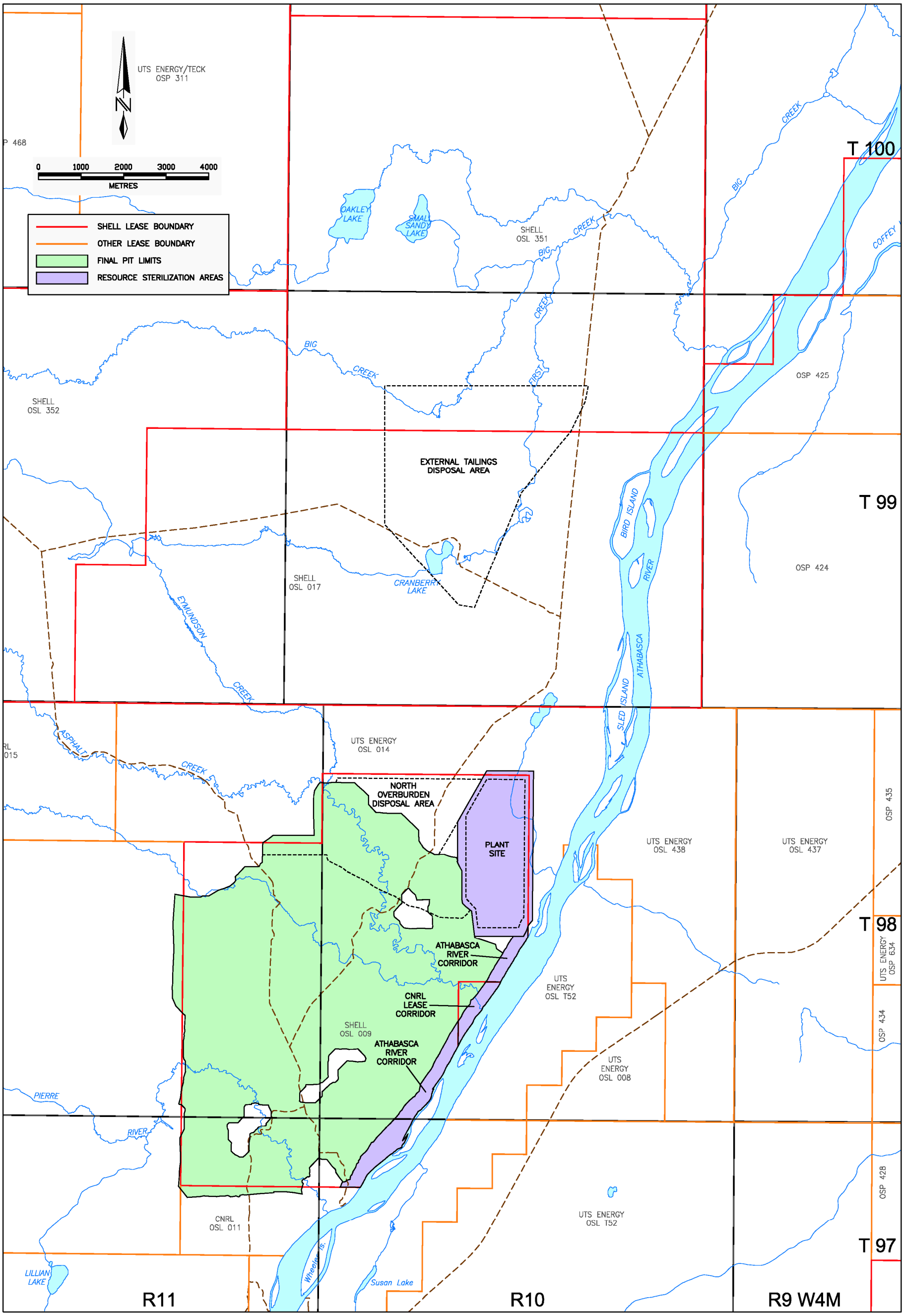


Figure 5-3: Facility Locations and Resource Sterilization Areas

PLANNING CRITERIA

The criteria in Table 5-4 were used to develop the Pierre River Mine plan.

Table 5-4: Pierre River Mine Planning Criteria

Planning Component	Criterion
Overall Operation	
Pierre River Mine Train 1 start-up	2018
Pierre River Mine Train 2 start-up	2021
Required mine life	22 years
Mine operation	365 days a year, 24 hours a day
Pierre River Mine Extraction Plant Operation	
Production of final product bitumen	30,000 m^3/cd (11.0 Mm^3/a)
Coarse rejects	3.5% (wt%)
Average feed grade	10.9% (wt%) bitumen

The Pierre River Mine contains 2,349 Mt of mineable oil sands ore, at an average feed grade of 10.9 wt% bitumen.

MINING CRITERIA

The mining criteria (see Table 5-5) are based on the EUB guidelines and current operating conditions at the Muskeg River Mine. As the Pierre River Mine develops, further site-specific detailed mine planning and engineering might result in minor changes to these criteria.

GEOTECHNICAL CONSIDERATIONS

Geotechnical Criteria

Table 5-6 provides the geotechnical criteria used in developing the mine plan. These criteria affect the disposal areas and pit walls of the Pierre River Mine.

The geotechnical properties of the various stratigraphic units are primarily based on geotechnical laboratory testing of materials from the Muskeg River Mine and the Jackpine Mine. Where no testing has been done on a facies unit, its shear strength parameters are engineered estimates based on regional data and

Geotechnical Criteria (cont'd)

experience. Because of the depth and their typically low residual strength, the critical stratigraphy controlling slope stability is lower McMurray clays (LM2).

Table 5-5: Pierre River Mine Mining Criteria

Component	Criterion
Ore	
Cut-off grade	7%
Grade dilution	0.3 wt% bitumen
Minimum separation thickness	3 m
Material in Situ Density	
Muskeg	1.25 t/bcm
Overburden and oil sands	2.1 t/bcm
Material Swell	
Muskeg (placed)	30%
Overburden and oil sands	10 to 20%

Table 5-6: Pierre River Mine Geotechnical Criteria

Component	Criterion
Open Pit Wall Design Parameters	
Maximum bench height	15 m
Safety berm	25 m
Maximum overall slope	3:1 (18º)
Reclamation Material Stockpiles	
Overall slope	4:1 (14º)
Maximum overall height	20 m
Overburden Disposal Areas	
Overall slope	4:1 (14º)
Maximum overall height	80 m
In-Pit Dyke Slopes	
Downstream slope	4:1 (14º)
Upstream slope	3:1 (18º)

Geotechnical Conditions

The geotechnical stability of the pit walls and North OBDA relies on understanding the key subsurface geological features. Table 5-7 shows the stratigraphy and geotechnical conditions of the development area.

The stratigraphy at locations around the pit and through the overburden and interburden storage is summarized as follows:

- the average thickness of Holocene surficial material is 2 m
- Pleistocene surficial material ranges between 0 m and 30 m thick
- localized Clearwater surficial material occurs up to 20 m thick
- the mine pit floor elevation is generally governed by the Devonian surface, which has localized pockets of LM2

Table 5-7: Stratigraphy of Pierre River Mine Development Area

Geological Unit	Sedimentary Facies	Lithology	Typical Thickness (m)
Holocene	Muskeg	Organic soil	1 – 3
	Eolian, fluvial and lacustrine	Sands and gravels, silts and clays	0 – 1
Pleistocene	Fluvial	Glacial till	0 – 15
	Lacustrine	Clays and silty clays	0 – 2
	Fluvial	Sands and gravels	0 – 30
McMurray Formation	Estuarine	Sands, silts, muds, rich and lean oil sands	10 – 30
	Lagoonal	Clay and silty clay	0 –20
	Fluvial	Sands, silts, muds, rich and lean oil sands	0 – 10
Devonian	Paleosol	Residual soil, high clay content	Highly variable up to 1.5
	Bedrock	Carbonate rock	Undetermined

Evaluation of Failure Mechanisms

A geotechnical analysis of mine slopes considered the potential failure mechanisms that might be present in an oil sands mining operation. These include:

- slumping of saturated glacial materials
- sliding on weak layers at residual strength
- flows in rich oil sands ore
- rapid loading of weak surficial materials
- slope instability of the external storage areas

The analysis did not identify any major instability that could threaten the integrity of the current mine plans for highwall, overburden and interburden storage layouts, which is supported by operational experience. A review of failure mechanisms shows that the most important stability issue is the presence of weak layers in the mining sequence.

Figure 5-4 shows a typical disposal cross-section. Figure 5-5 shows the design detail for a final highwall.

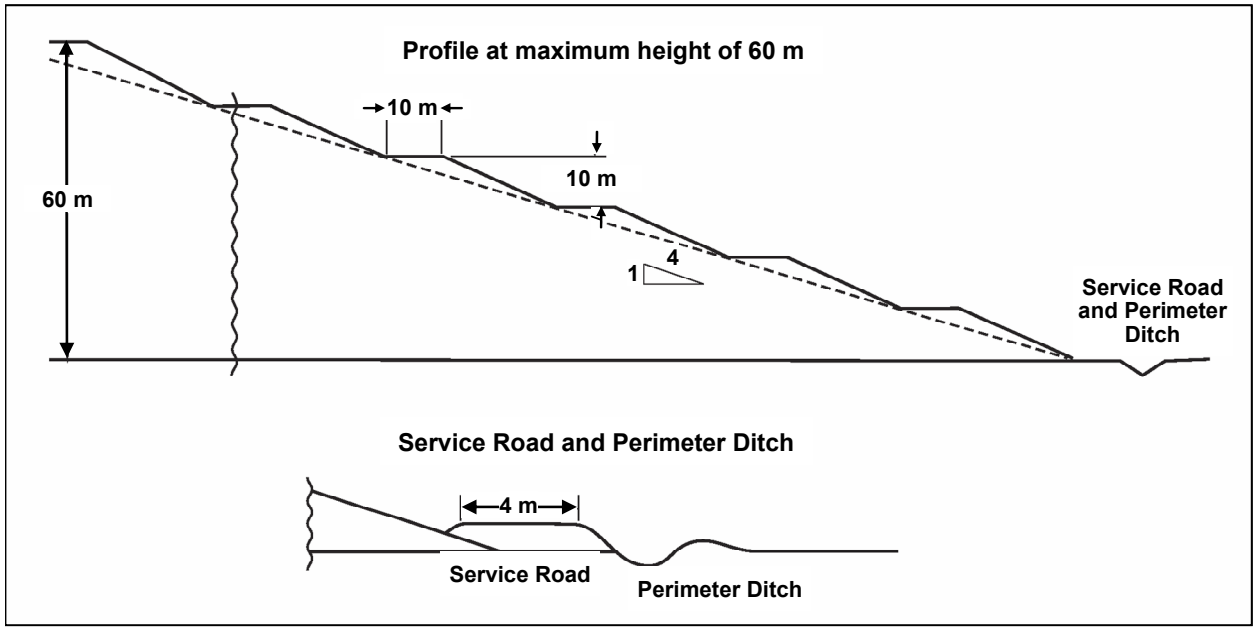


Figure 5-4: Typical Overburden Disposal Area Cross-Section

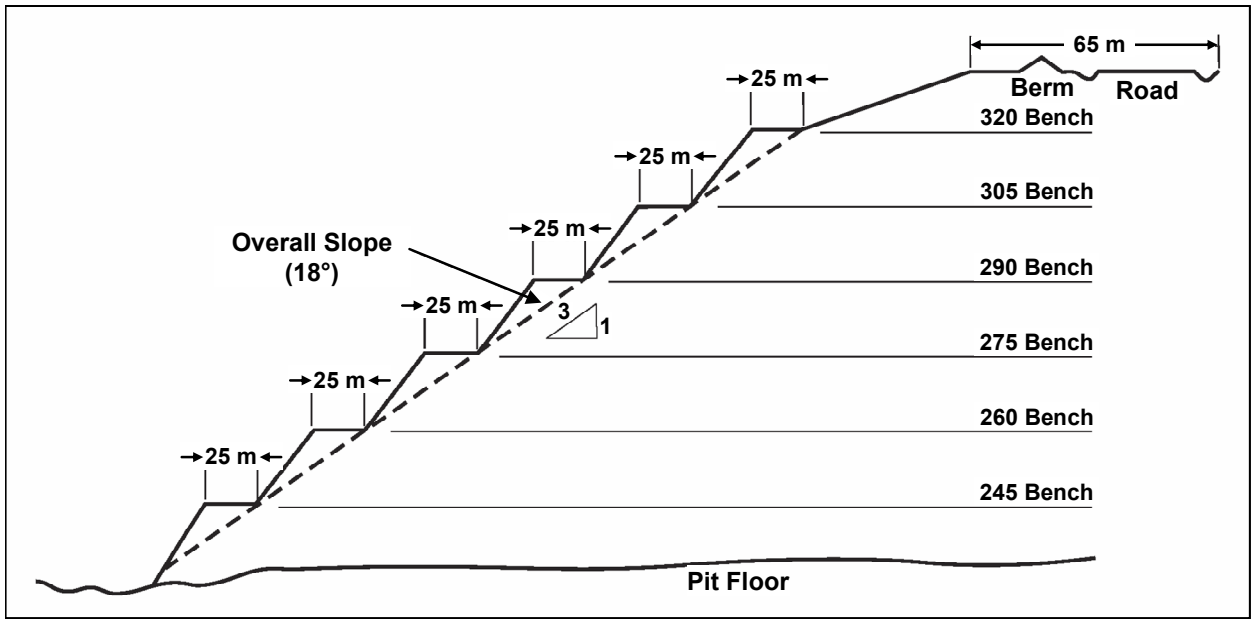


Figure 5-5: Highwall Design

MINE DEVELOPMENT SCHEDULE

Table 5- 8 details the Pierre River Mine production schedule. It provides annual summaries of bitumen produced, ore grades and tonnage mined, and quantities of total overburden and interburden handled from the mining areas. For general mine layout and mining sequence, see:

- Figure 5-6, Pierre River Mine Life Development Plan
- Figure 5-7, Annual Pit Face and Overburden Disposal Area Progressions

Once at full production, the combined annual ore production rate for the Pierre River Mine will range from 113 to 146 Mt/a. The average diluted ore grade will be between 10.1 and 11.8 wt% for most of the mine's life. However, the diluted ore grade will drop below 10.0 wt% in 2036. Initial mining will concentrate in a high-grade ore zone near the crusher slot. Ore grades will exceed 11.0 wt% every year for the first 12 years of operation. In years 13 to 22, the grade will average 10.67 wt%.

The in-pit ore crusher stations are designed to be relocated, to reduce haul distances and, thereby, the number of haul trucks required as the mine progresses. During the life of the mine, the crushers will be relocated once, in 2033. Initially, the crushers will be positioned adjacent to the processing plant. The surge feed conveyors will be relocated and extended 5.2 km to service the new location. Figure 5-8 shows the crusher conveyor locations and timing.

Table 5-8: Annual Mine Production Schedule

Year	Waste Material (Mbcm)	Oil Sands (Mt)	Diluted Ore Grade (wt%)	Final Product Bitumen (Mm^3)	Strip Ratio (m^3/m^3)
Pre-Production	25				
2018	4	6	11.45	1	1.30
2019	36	20	11.52	2	3.80
2020	35	57	11.46	5	1.29
2021	39	69	11.11	6	1.16
2022	37	79	11.00	7	0.99
2023	38	119	11.28	11	0.67
2024	45	122	11.09	11	0.76
2025	62	114	11.54	11	1.14
2026	60	121	10.91	11	1.03
2027	66	120	11.14	11	1.14
2028	54	113	11.75	11	0.99
2029	50	121	11.17	11	0.87
2030	58	124	10.93	11	0.98
2031	59	124	10.91	11	0.98
2032	60	114	11.63	11	1.09
2033	60	130	10.54	11	0.95
2034	60	121	11.16	11	1.03
2035	52	137	10.13	11	0.79
2036	53	146	9.72	11	0.75
2037	50	137	10.19	11	0.76
2038	26	133	10.42	11	0.40
2039	12	123	10.94	11	0.20
Total	**1,040**	**2,348,923**		**207**	
Weighted Average			**10.90**		**0.92**

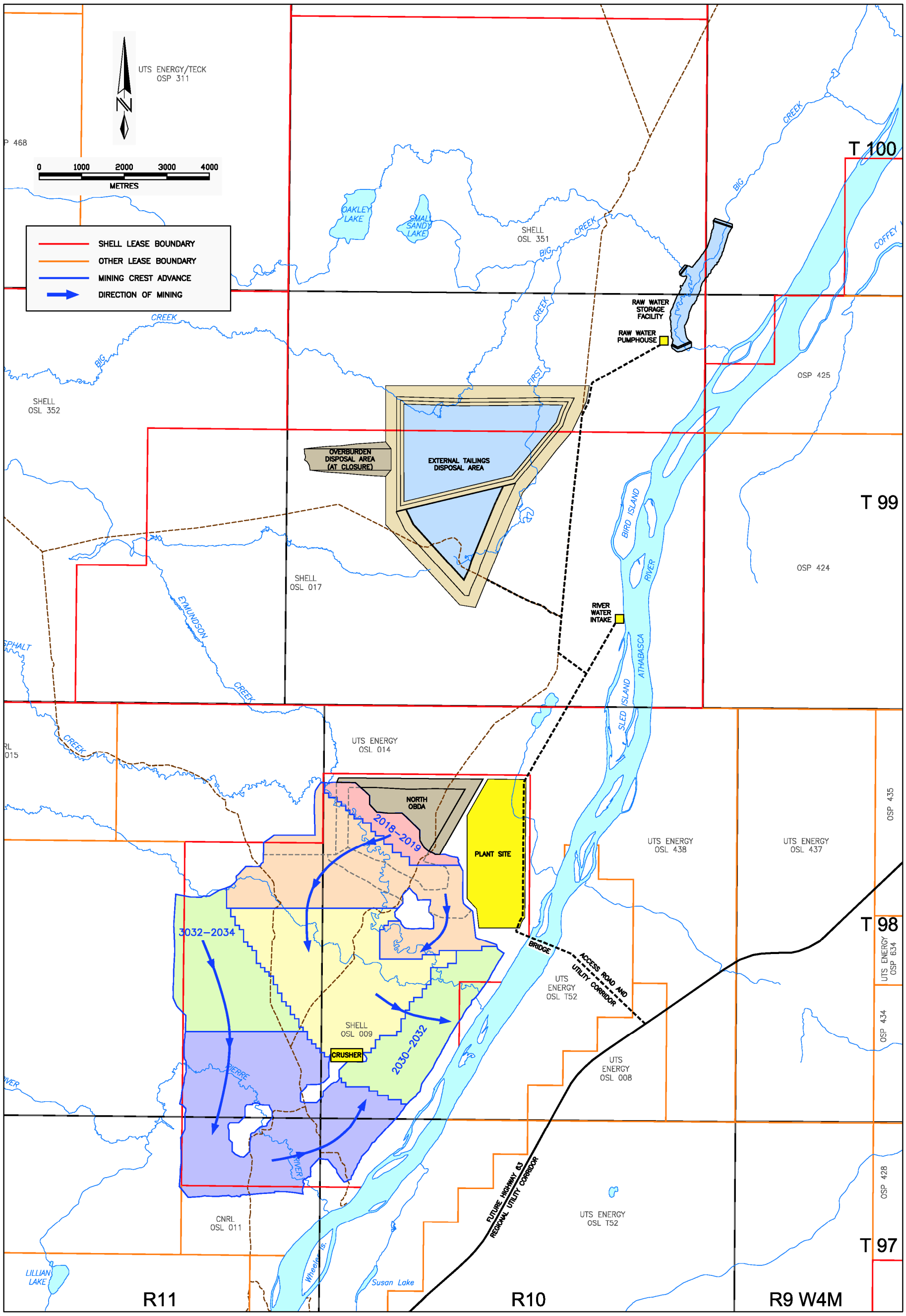


Figure 5-6: Pierre River Mine Life Development Plan

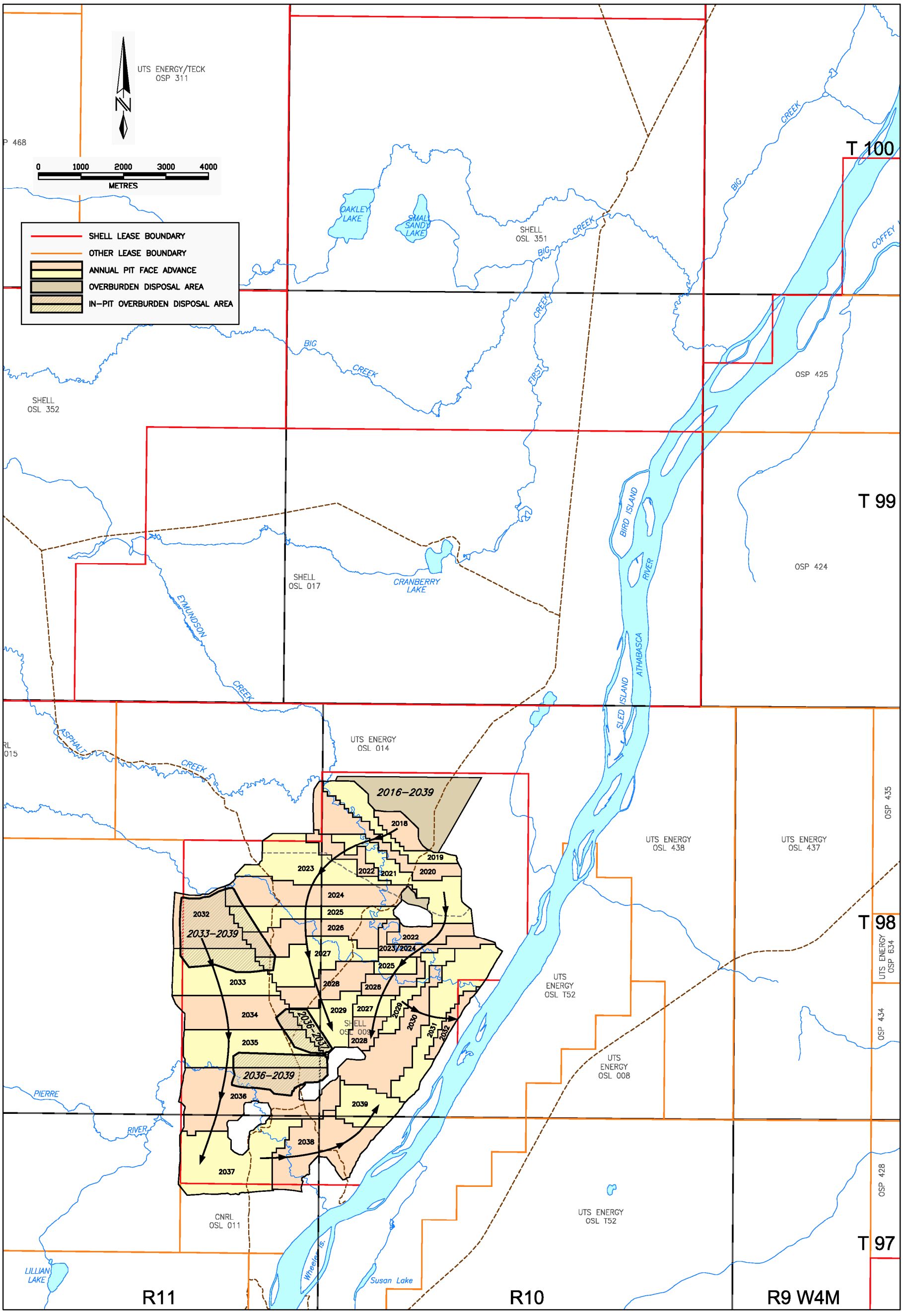


Figure 5-7: Annual Pit Face and Overburden Area Progressions

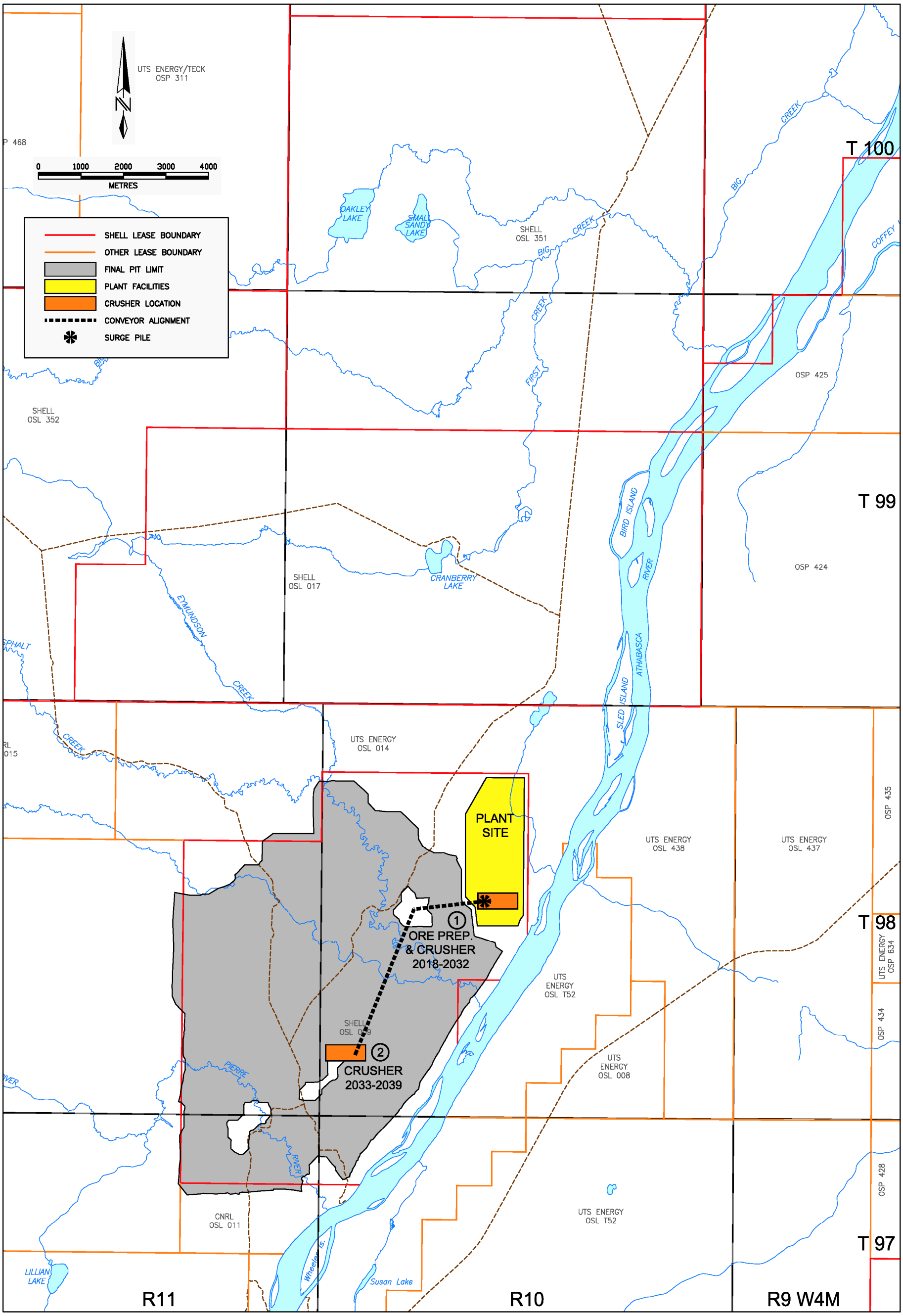


Figure 5-8: Crusher Conveyor Locations and Timing

MATERIALS SUITABLE FOR CONSTRUCTION

Table 5-9 shows the waste material balance and the total quantity of waste material, including plant rejects and excluding reclamation materials.

Table 5-9: Waste Material Balance

Year	Total Waste Placed					
	Total Waste (Mbcm)	Overburden Disposal Area (OBDA) (Mbcm)	In-Pit Dumps (Mbcm)	Cell Capping (Mbcm)	ETDA (Mbcm)	In-Pit and Perimeter Dykes (Mbcm)
Pre-Production	25	7	0	0	19	0
2018	4	4	0	0	0	0
2019	36	36	0	0	0	0
2020	36	31	0	0	5	0
2021	40	33	0	0	7	0
2022	39	34	0	0	2	2
2023	40	23	0	0	5	12
2024	47	30	0	0	2	15
2025	64	27	0	0	0	37
2026	62	26	0	0	0	36
2027	68	31	4	0	0	33
2028	56	28	2	0	0	25
2029	52	30	4	0	0	18
2030	60	38	10	0	0	12
2031	61	32	14	0	0	16
2032	62	30	24	0	0	8
2033	62	2	58	0	0	1
2034	62	2	47	0	0	12
2035	54	2	31	0	0	21
2036	55	2	38	0	0	14
2037	52	2	28	20	0	2
2038	28	2	4	19	0	3
2039	14	2	3	7	0	2
Total	**1,080**	**456**	**267**	**46**	**40**	**270**

MATERIALS SUITABLE FOR CONSTRUCTION (cont'd)

Suitable construction materials were identified in the overburden and interburden materials. Overburden construction material consists of overburden tills and Pleistocene granular materials. Interburden construction material consists of lean oil sands found in the McMurray Formations. Unsuitable material will be disposed of in overburden disposal areas, in-pit dyke berms and in-pit dumps within the pit cells. The in-pit dykes consist of suitable construction materials designed with a 4:1 downstream slope and 3.1 upstream slope. The detailed waste material balance maximizes the in-pit space left for tailings.

Waste mined in the early years will be hauled to the ETDA starter dykes and the North OBDA. Once enough mine floor space is available, waste suitable for construction will be used to build the dykes to contain the tailings in pit.

Waste quantities will fluctuate from 14 to 68 Mm^3/a. The waste quantities will increase annually until 2027, when they will peak at 68 Mm^3/a. After 2027, the annual waste quantities will average 52 Mm^3/a. Waste quantities will average about 48 Mm^3/a throughout the mine plan.

Overburden and lean oil sands will be used throughout the mine life for:

- dyke and road construction
- tailings cell cap material

Overburden not used for dykes and cell capping will be disposed of in OBDAs and in-pit dumps in the pit cells.

The Pierre River Mine was designed to minimize the disturbance beyond Lease 9 and to minimize haul distances. Because of the limited space available on Lease 9 for external waste disposal, the North OBDA will be extended into the pit as mining advances from north to south. Table 5-10 shows the capacity of the North OBDA.

Table 5-10: Overburden Disposal Area Capacities

Disposal Area	Description	Capacity (Mm^3)	Operating Period
North OBDA	North dump	112	2016–2023
North OBDA	North dump – in-pit	344	2023–2039

IN-PIT CONSTRUCTION SCHEDULES

Table 5-11 shows the in-pit construction schedule, from 2018 to 2039 for the Pierre River Mine. Table 5-12 shows the in-pit tailings cell capping schedule, from 2034 to 2039, for non-segregating tailings (NST) Cells 1 to 4.

Table 5-11: In-Pit Dyke Construction Schedule

Year	Total In-Pit Dykes (Mbcm)	Pierre River Mine Dyke Number (Mbcm)												
		1	2	3	4	Cell 1 OT	5	6	7	8	10	11	12	14
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	2	0	2	0	0	0	0	0	0	0	0	0	0	0
2023	12	5	2	0	3	0	0	2	0	0	0	0	0	0
2024	15	5	2	0	3	0	0	5	0	0	0	0	0	0
2025	37	7	2	17	3	0	0	8	0	0	0	0	0	0
2026	36	6	2	17	3	0	0	8	0	0	0	0	0	0
2027	33	2	0	17	0	4	0	10	0	0	0	0	0	0
2028	25	0	0	0	0	7	5	14	0	0	0	0	0	0
2029	18	0	0	0	0	6	7	5	0	0	0	0	0	0
2030	12	0	0	0	0	0	10	0	2	0	0	0	0	0
2031	16	0	0	0	0	0	10	0	6	0	0	0	0	0
2032	8	0	0	0	0	0	2	0	4	1	0	0	0	0
2033	1	0	0	0	0	0	0	0	0	1	0	0	0	0
2034	12	0	0	0	0	0	0	0	0	1	11	0	0	0
2035	21	0	0	0	0	0	0	0	0	0	11	0	0	10
2036	14	0	0	0	0	0	0	0	0	0	11	0	0	3
2037	2	0	0	0	0	0	0	0	0	0	0	2	0	0
2038	3	0	0	0	0	0	0	0	0	0	0	2	2	0
2039	2	0	0	0	0	0	0	0	0	0	0	0	2	0
Total	**270**	**26**	**11**	**51**	**11**	**17**	**34**	**52**	**12**	**4**	**33**	**4**	**3**	**13**

Note: OT = overtopping

Table 5-12: In-Pit Dumping and Cell Capping Schedule

Year	Cell Capping with Overburden			
	Total (Mbcm)	Cell 1 (Mbcm)	Cell 2 (Mbcm)	Cell 4 (Mbcm)
2034-2036	0	0	0	0
2037	20	20	0	0
2038	19	19	0	0
2039	7	7	0	0
Mine decommissioning	114	0	99	15
Total	**160**	**46**	**99**	**15**

TAILINGS DISPOSAL SCHEDULE

The volumetric schedules for the tailings plan (dykes, cells and in-pit disposal areas) were developed in association with the mining plan. In 2018, tailings deposition using conventional methods will begin in the ETDA south of the extraction plant. This area will be used until the end of 2029. For the Tailings Management Plan, see Section 7.

MINING STATUS

Preparation of the Pierre River site will begin in 2010 to provide sufficient time for access roads, clearing and drainage.

The status maps of the first 10 years of mining are shown in:

- Figure 5-9: Mining Status – End of 2010
- Figure 5-10: Mining Status – End of 2014
- Figure 5-11: Mining Status – End of 2015
- Figure 5-12: Mining Status – End of 2016
- Figure 5-13: Mining Status – End of 2017
- Figure 5-14: Mining Status – End of 2018
- Figure 5-15: Mining Status – End of 2019

The status maps for five-year snapshots are shown in:

- Figure 5-16: Mining Status – End of 2024
- Figure 5-17: Mining Status – End of 2029
- Figure 5-18: Mining Status – End of 2034
- Figure 5-19: Mining Status – End of 2039

MINE DEVELOPMENT PHASES

The mine sequences for the phases of mine development are:

- period from 2011 to 2019
- period from 2020 to 2024
- period from 2025 to 2029
- period from 2030 to 2034
- period from 2035 to 2039

Preproduction will begin in 2010 with road access. Clearing, drainage and construction of the plant, the external tailings facility and the raw water pond will be developed before Q4 2018.

Pre-stripping of overburden will start in 2016 to support the construction of the external tailings area starter dykes, which require 19 Mm^3 of material.

MINE DEVELOPMENT PHASES (cont'd)

The opening cut at the Pierre River Mine will start adjacent to the west side of the plant and will be developed southwest through the high-grade ore area. Overburden and interburden material will be transported by truck to the North OBDA and the ETDA dyke.

At the end of 2019, the North OBDA will be active. Ore will be transported by truck to the crusher.

Site drainage and muskeg removal will progress to the south, ahead of the mining face.

STATUS BETWEEN 2020 AND 2024

The mining face will rotate directly south, and mining will proceed in that direction along two mining faces around the northern island. Ore will be transported by truck to the crusher.

Waste will continue to be disposed of in the North OBDA. The mining advance will clear the pit floor for construction of in-pit Dykes 1, 2, 4 and 6 during this period.

Site drainage and muskeg removal will be completed to the south of the mining area.

STATUS BETWEEN 2025 AND 2029

Mining will continue southward with two fleets clearing the base of feed for Dykes 5 and 6. In 2029, both fleets will join and turn east to clear the base of feed for Dykes 3, 5 and 6. Ore will be transported by truck to the crusher.

Waste will continue to be transported to the North OBDA, which by this time will be developed in two phases. The out-of-pit portion will be built to an elevation of 310 m, and the in-pit portion will be built from the pit floor to an elevation of 280 m.

In-pit Dykes 1, 2, 3, 4 and 6 and the Cell 4 overtopping dyke will be completed during this period, and Dyke 5 will be under construction.

Site drainage and muskeg removal will be completed to the east pit limit adjacent to the Athabasca River. Clearing will then move to the west of Dyke 3 and progress southward.

STATUS BETWEEN 2030 AND 2034

Mining will reach the east pit limit along the Athabasca River. The mining fleet will move to the northwest and advance southward. Ore will be transported by truck to the new south in-pit crusher.

In-pit Dykes 5, 7 and 8 will be completed during this period. The CNRL boundary dump and the Cell 4 in-pit dump will be active. The North OBDA will reach the final design elevation of 340 m, and the northern portion of the dump will be reclaimed. In-pit Dyke 10 will be under construction.

Site drainage and muskeg removal will continue southward on the west side of the mine. Clearing will rotate east at the southern pit limit and progress toward the Athabasca River.

STATUS BETWEEN 2035 AND 2039

Mining will continue to the southern pit limit then rotate east toward the Athabasca River. In-pit Dykes 9, 10, 11 and 12 and the Cell 5 overtopping dyke will be completed. In-pit dumps in Cells 4 and 5 will be active during this period.

Overburden capping of in-pit tailings Cell 1 will be completed. All ore will be hauled to the south crusher station.

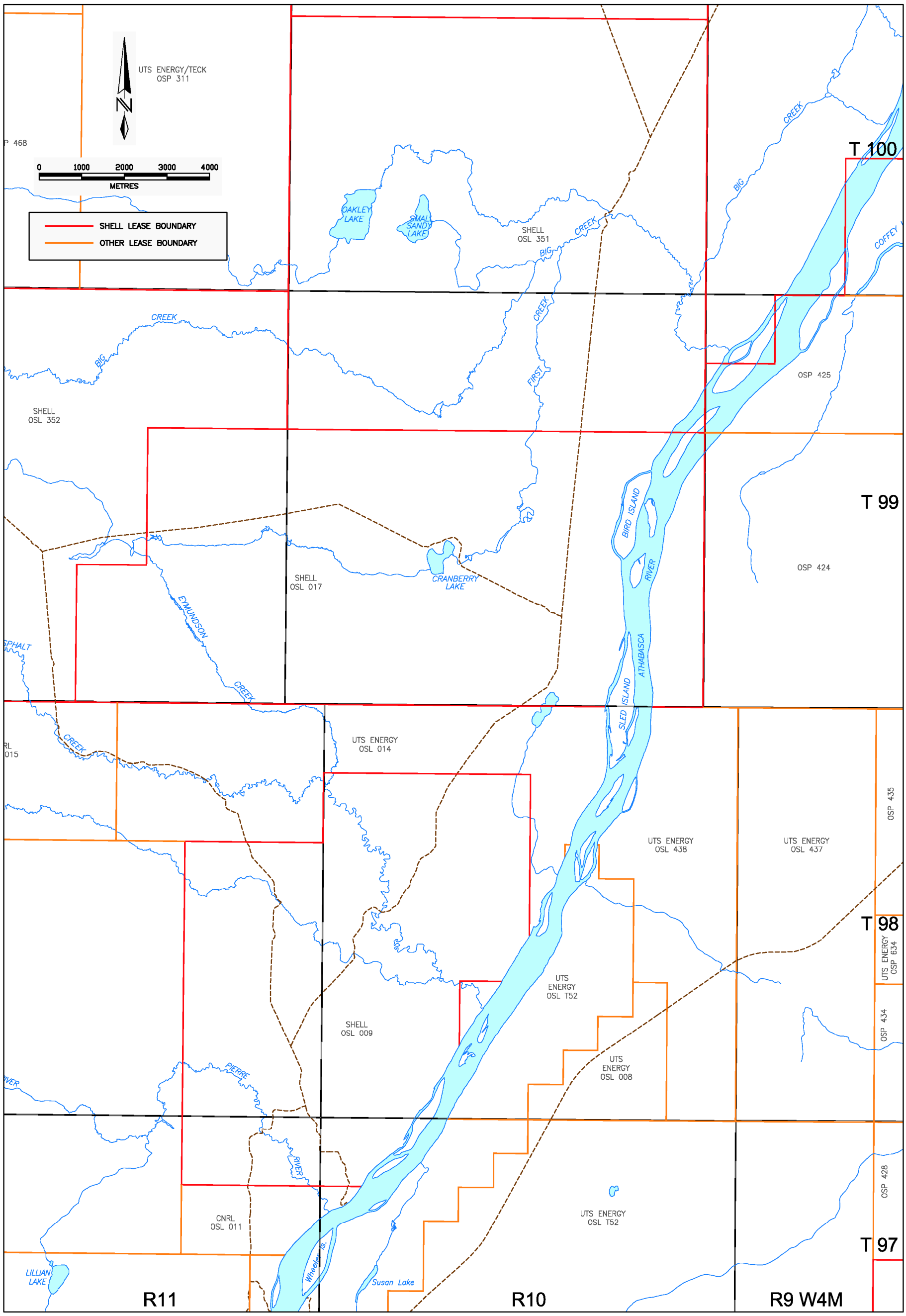


Figure 5-9: Mining Status – End of 2010

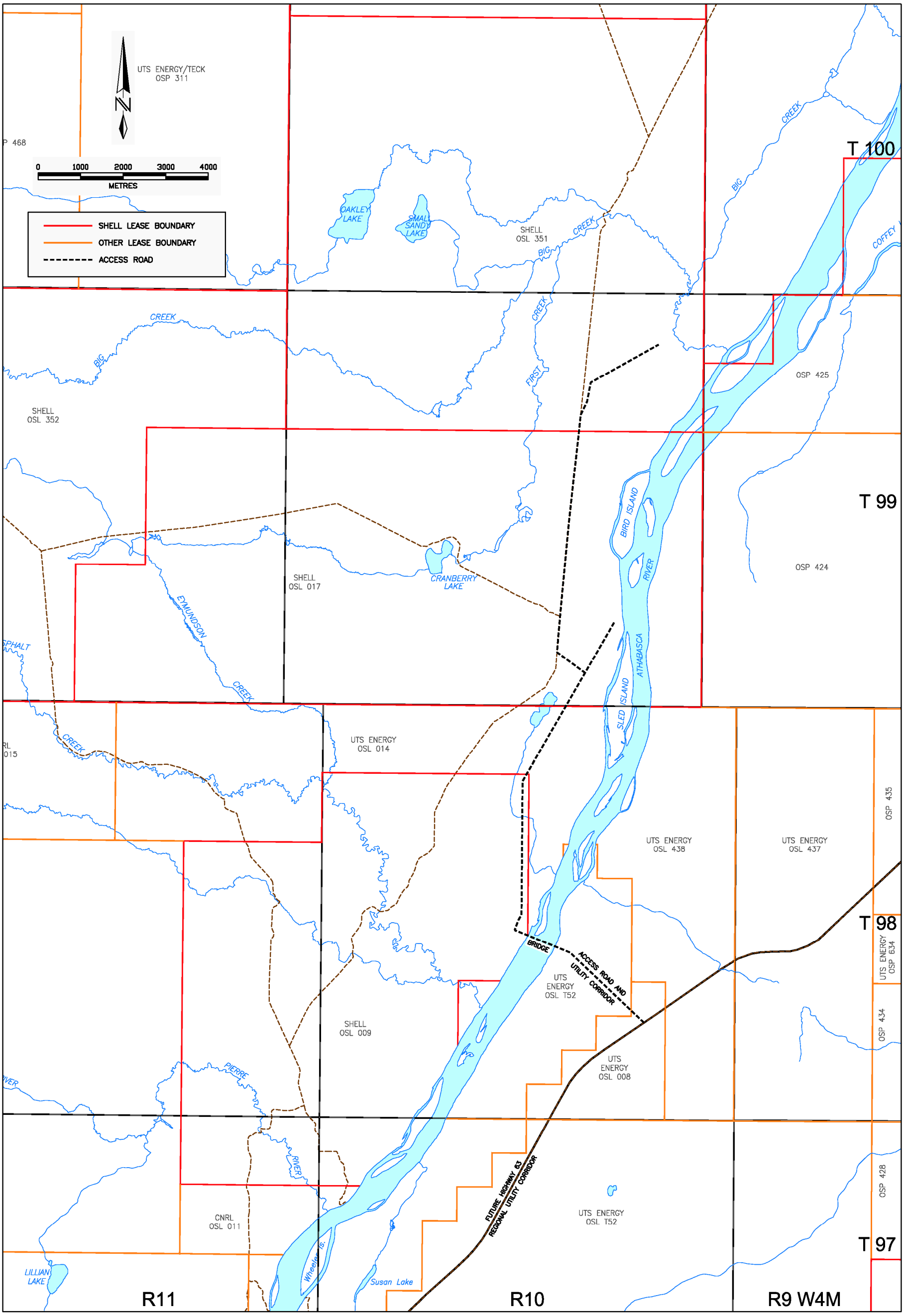


Figure 5-10: Mining Status – End of 2014

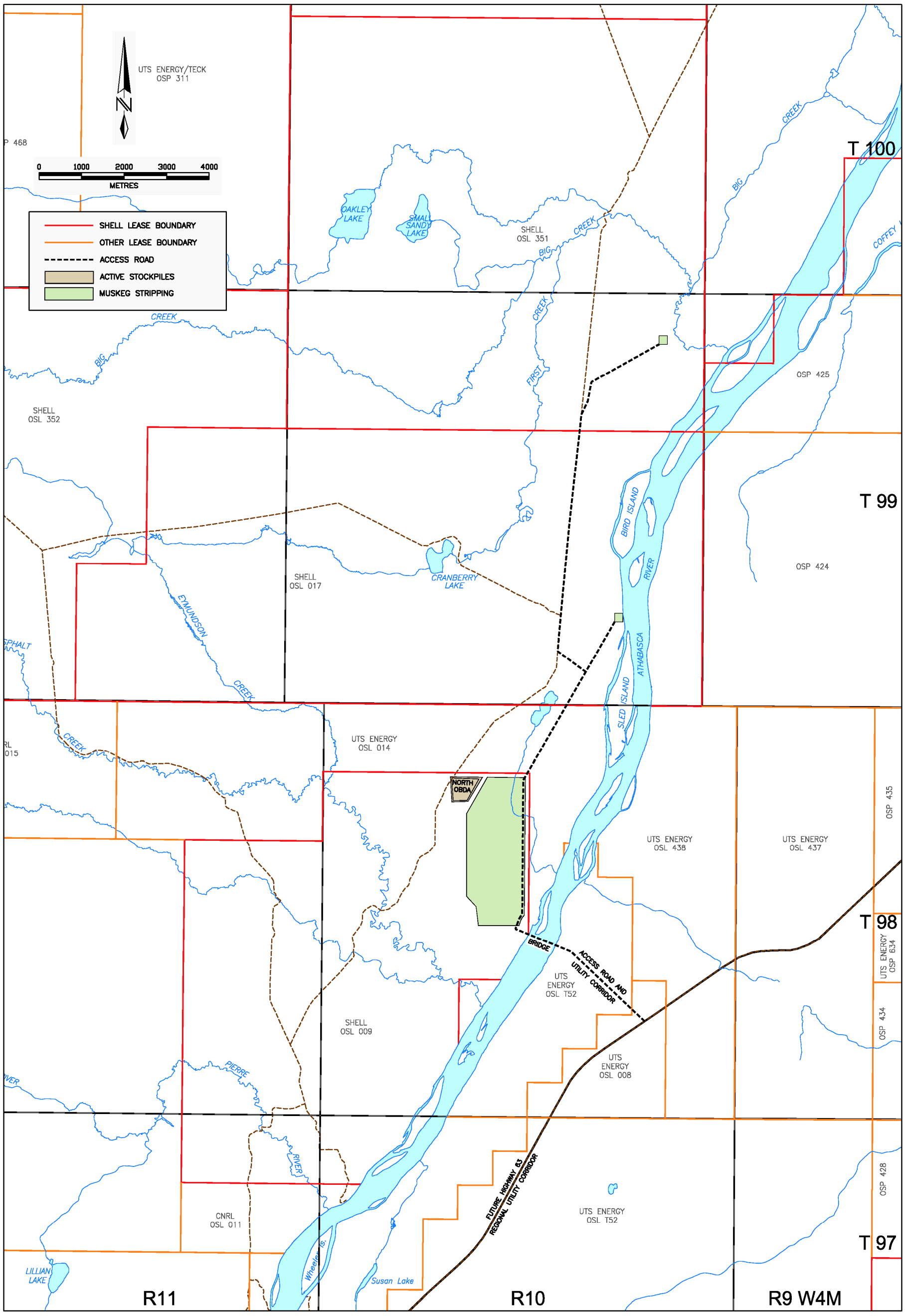


Figure 5-11: Mining Status – End of 2015

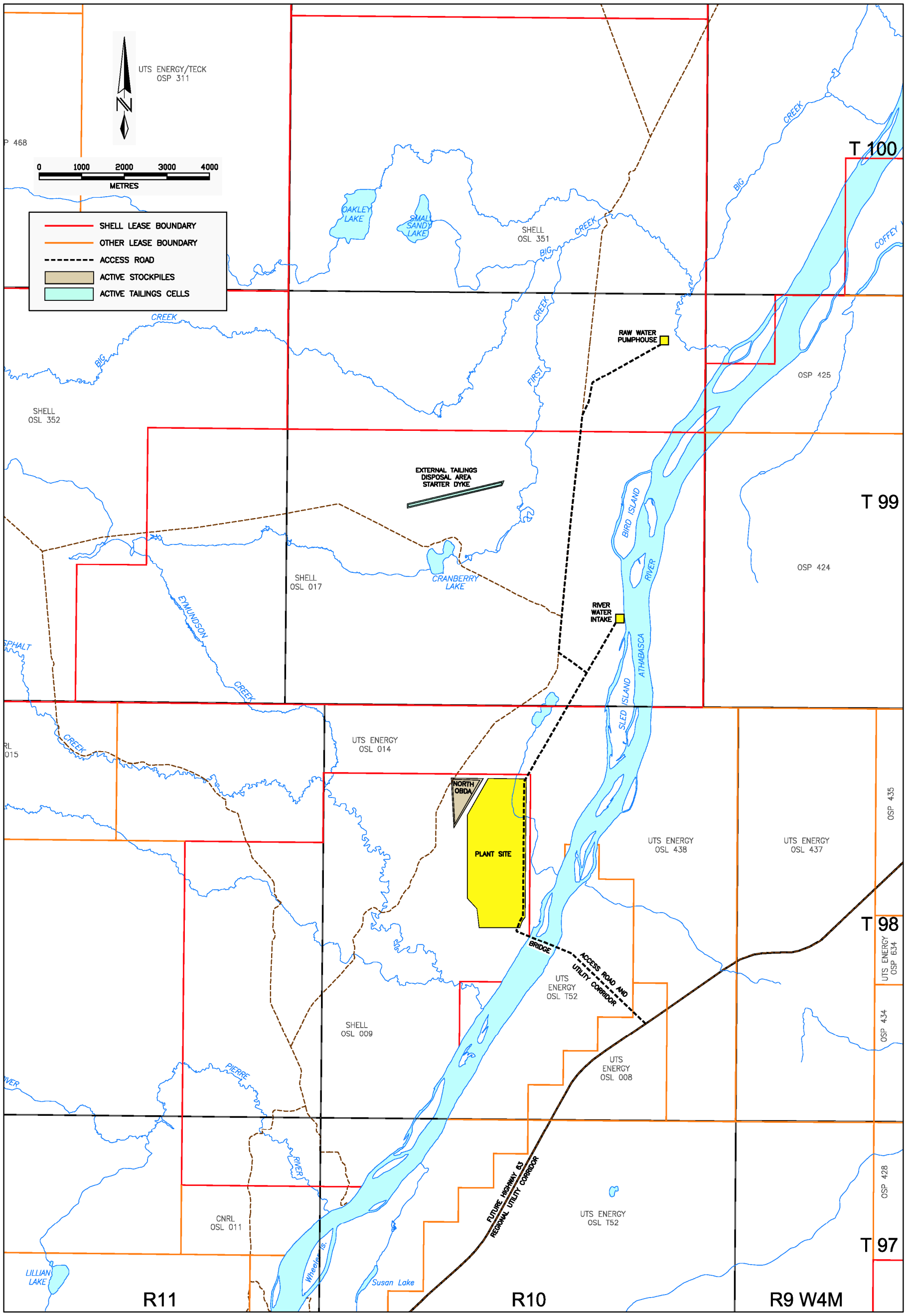


Figure 5-12: Mining Status – End of 2016

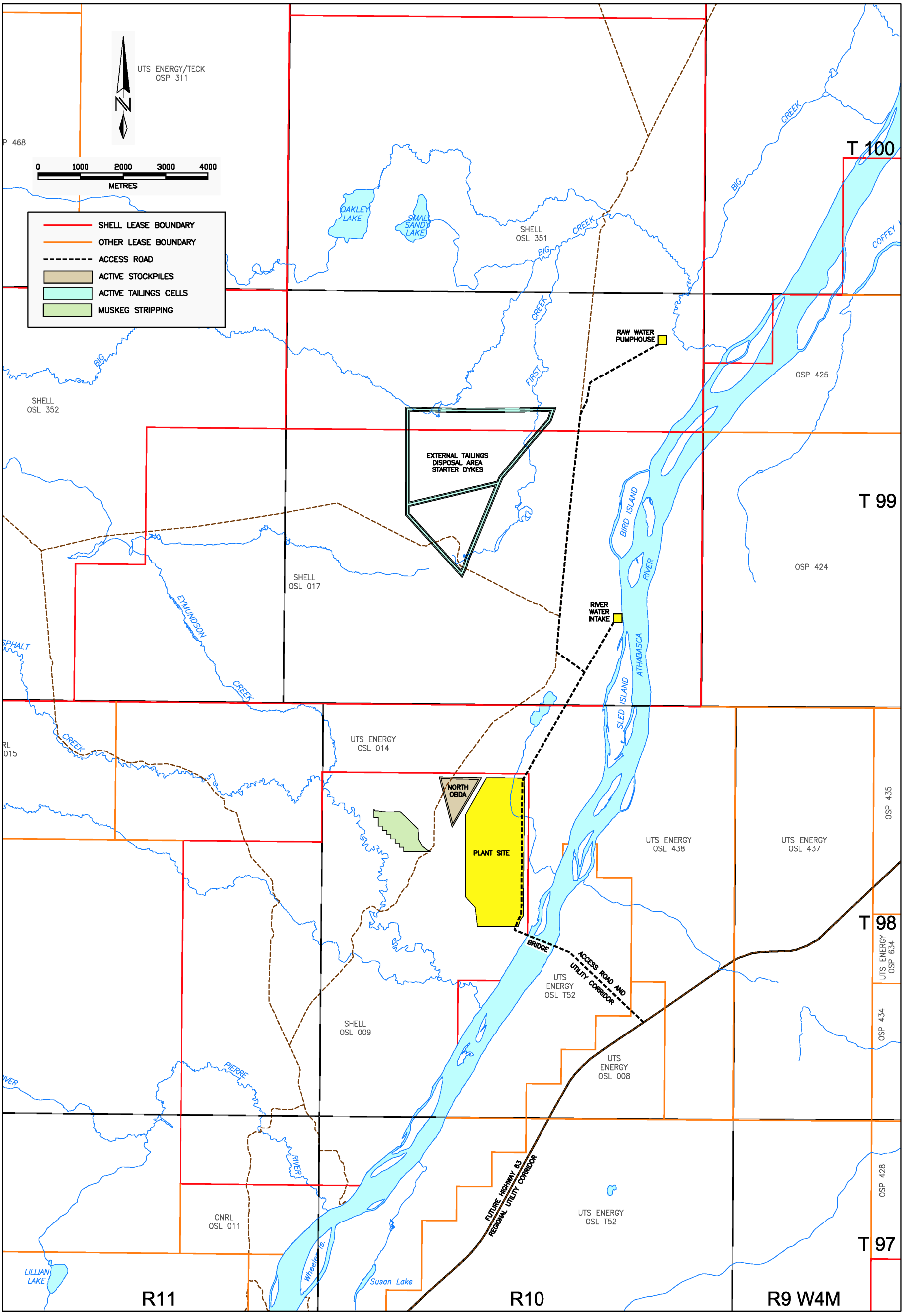


Figure 5-13: Mining Status – End of 2017

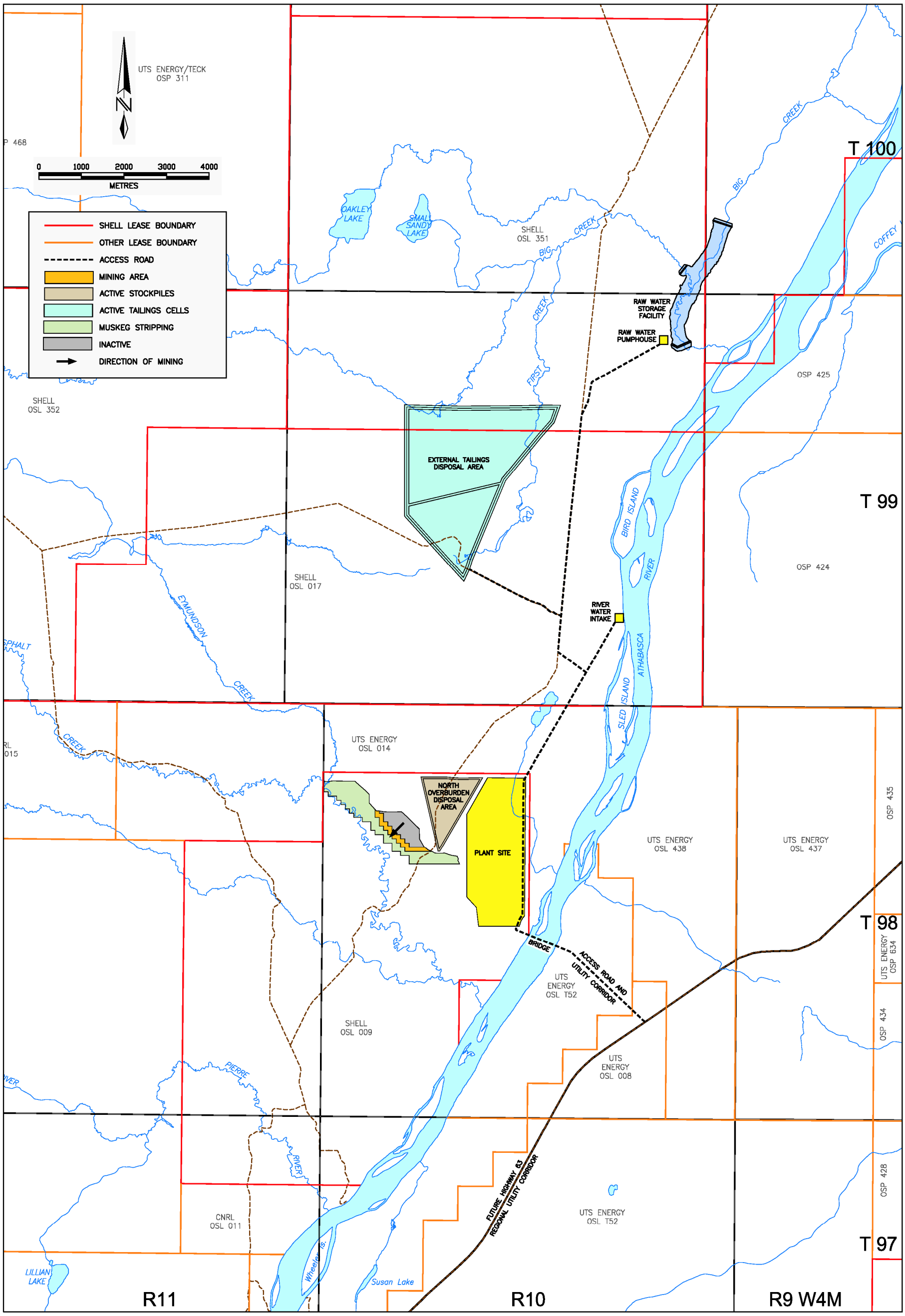


Figure 5-14: Mining Status – End of 2018

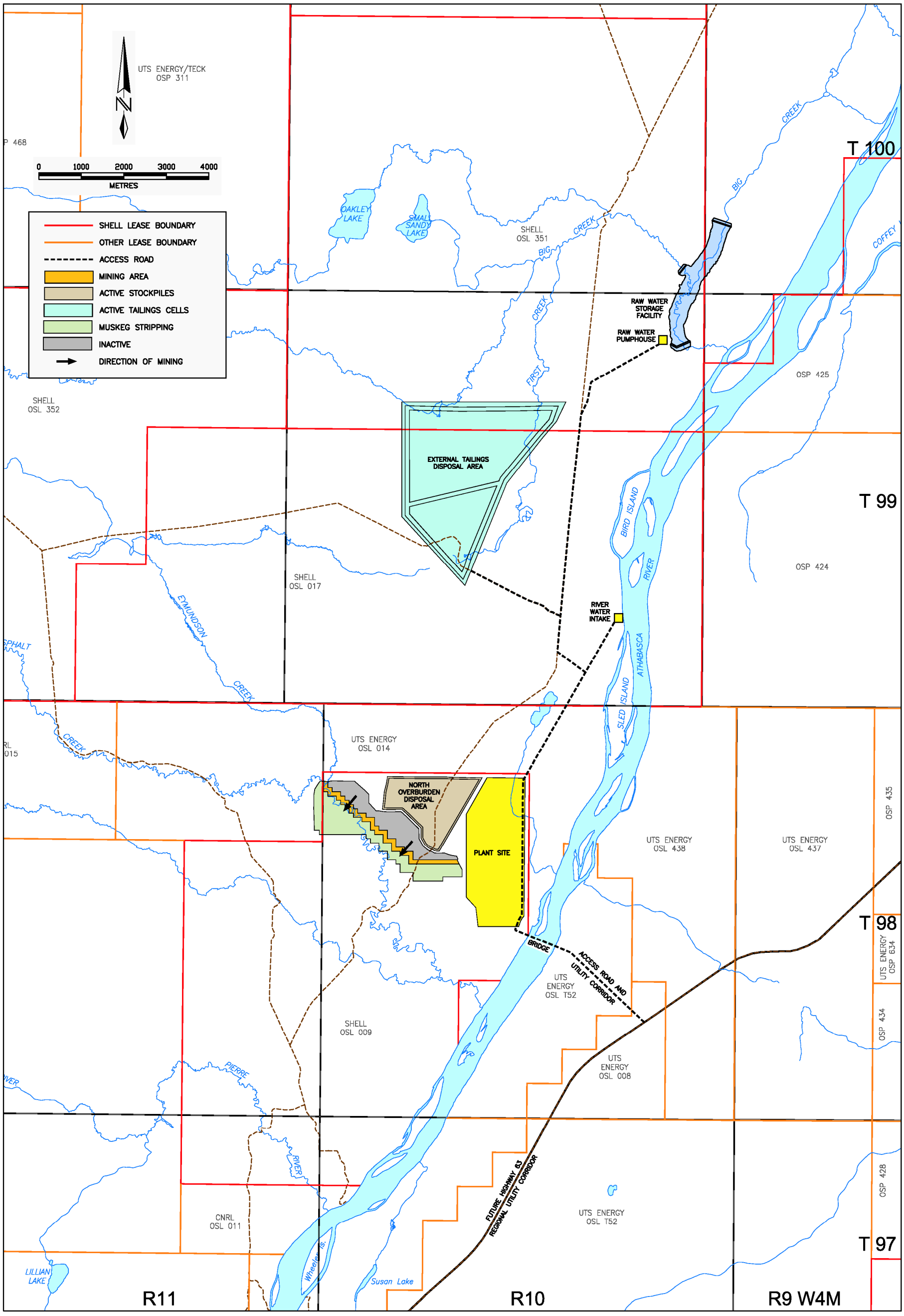


Figure 5-15: Mining Status – End of 2019

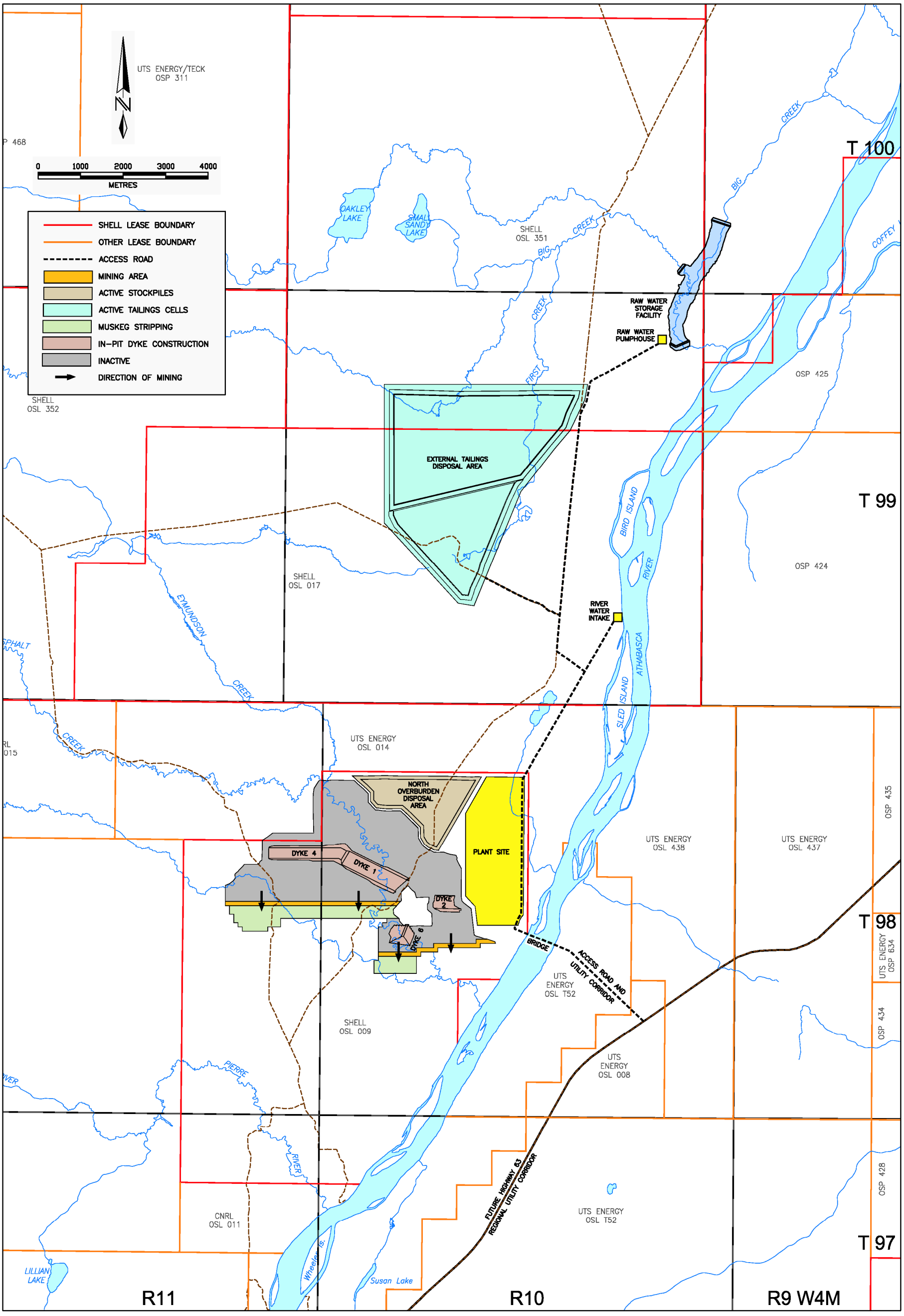


Figure 5-16: Mining Status – End of 2024

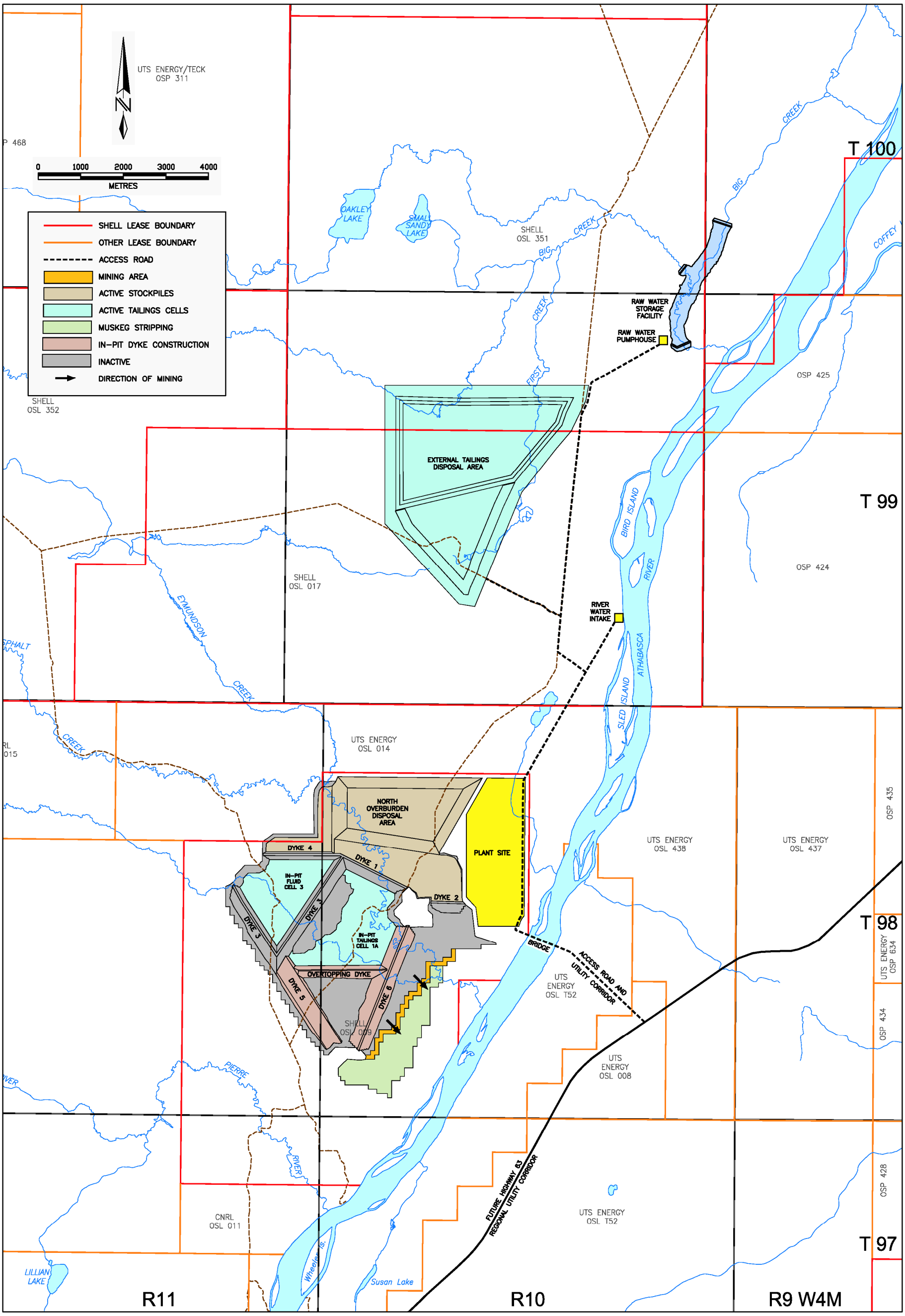


Figure 5-17: Mining Status – End of 2029

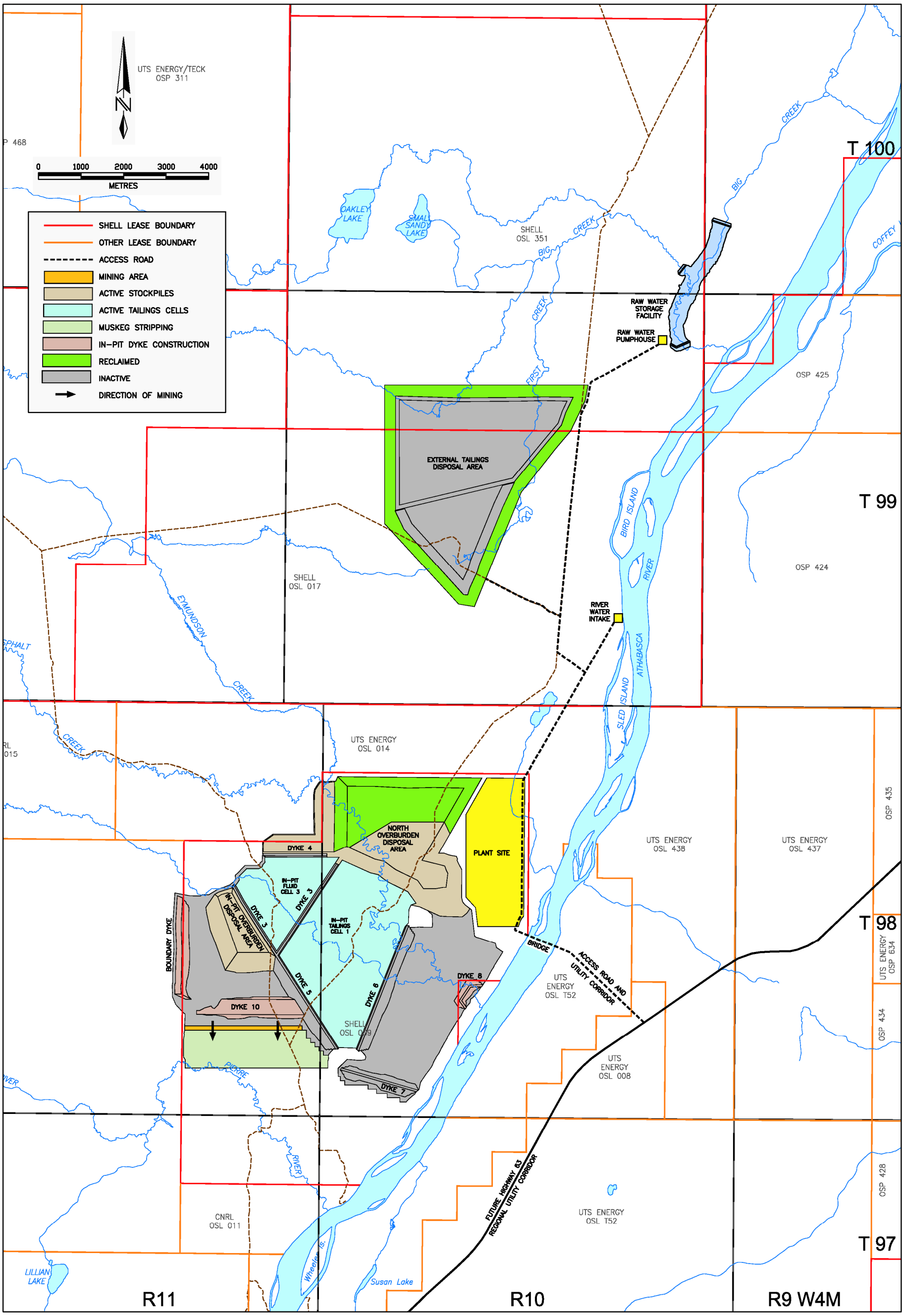


Figure 5-18: Mining Status – End of 2034

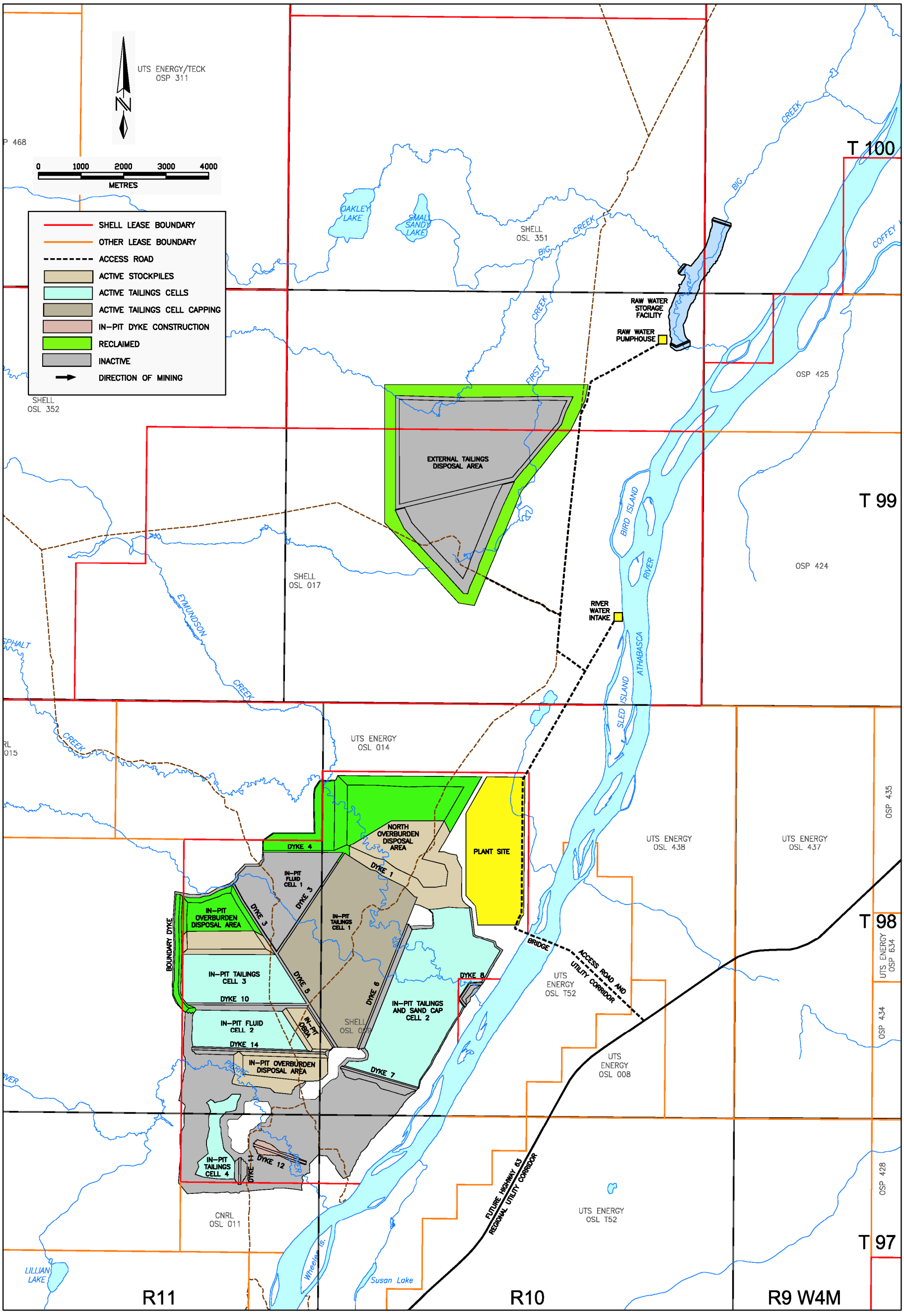


Figure 5-19: Mining Status – End of 2039

SCOPE

The preproduction activities for the Pierre River Mine include:

- constructing access to the site
- preparing the site
- prestripping
- constructing the external tailings disposal area starter dykes
- depressurizing the basal aquifer

SITE ACCESS

Access to the Pierre River Mine site will be via Highway 63 and the Fort Chipewyan winter road. To reach the site access road, about 27.8 km of the Fort Chipewyan winter road will require upgrading. The proposed access road from the Fort Chipewyan winter road will be about 3.5 km long. A new permanent bridge over the Athabasca River will be required to access the Pierre River Mine site.

After the main access roads and the Athabasca River bridge are constructed, which is currently planned for completion in 2013, 19 km of temporary roads will be constructed to connect the proposed plant site to the ETDA and the raw water intake facility.

SITE PREPARATION

Preparation of the Pierre River site for mining will begin in 2014 with clearing, followed by muskeg removal in 2015. To enable muskeg drainage ditches to be constructed, the land surface will be cleared in the:

- plant site
- ETDA
- initial mine area
- raw water facility area

PRESTRIPPING

Prestripping activities will begin as soon as the initial mine area has been cleared, ditched and drained, and the muskeg removed. The material for the ETDA will come from the overburden obtained from the initial mining area.

The initial mine opening will be adjacent to, and west of, the extraction plant. The truck dumping elevation will be about 280 m. The plant is scheduled to begin commissioning in September 2018 and begin full production operations by October 1, 2020.

TAILINGS STARTER DYKE CONSTRUCTION

About 19 Mbcm of material will be required to construct the external tailings disposal area starter dykes. All material will come from the working faces in the first mining block. Any unsuitable material will be sent to the North OBDA.

DEWATERING AND BASAL AQUIFER DEPRESSURIZATION

The oil sands deposit is underlain by basal aquifers ranging from 0 m to 50 m thick. These basal aquifers will be depressurized to ensure the stability of the mining floor.

Depressurizing the basal aquifers will begin when the ore processing plant is commissioned. Initially, this will require about five wells, spaced around the perimeter of the initial mining area. Each well will be designed to pump about 1,200 m^3/cd through a buried pipeline to the ETDA. The life of mine average predicted rate is 800 m^3/cd.

To support the dewatering system, a perimeter road will be required for servicing the wells. In addition, each well will be serviced by a 25 kV electrical power line and a transformer. Additional wells will be added as mining progresses.

The basal aquifer depressurizing system will remain in operation over the entire mine life. Water from the basal aquifer will be used for process makeup water.

CLEARING

Tree and vegetation clearing will continue progressively to complete the ditching, draining and removal of muskeg in advance of the active mine face, and to provide sufficient time for development drilling. Clearing will be completed three years in advance of mining. Merchantable timber will be recovered by logging contractors, and the balance of the slash will be chipped, where practical, or piled and burned.

OVERBURDEN DEWATERING

The Pierre River Mine area is intersected by rivers and some high areas, ranging in elevation from about 250 to 300 m. The area is characterized by gentle slopes, and a well-defined drainage system. The rivers drain into the Athabasca River.

Surface water runoff will be collected by ditching and routed through sedimentation ponds. Finger ditches will be constructed annually to drain the muskeg areas before muskeg is removed, and to divert surface water from wet areas. Overburden materials will be dewatered in areas where construction material capture is required. Overburden dewatering will be accomplished by using a combination of shallow wells and ditching. Suitable monitoring will be installed at the sedimentation ponds before water is discharged to the environment.

Runoff from the overburden disposal area will be collected in perimeter ditches and sedimentation ponds. Suitable monitoring will be done before the water is released to the environment. If the water is unsuitable for release, pipelines will transport it to the in-pit mine water system.

In-pit ditches will divert water from the active mining areas to sumps. The water in the sump will then be transported, via pipelines, to the plant recycle pond and be used in the bitumen recovery process.

For further information on surface drainage, see the Water Management Plan in EIA Volume 4A, Aquatic Resources.

MUSKEG REMOVAL

After an area has been cleared and drained, the muskeg will be removed. Muskeg will be removed during the winter and hauled to a reclamation material stockpile or the designated OBDA. To reduce stockpiling, muskeg required as reclamation material will be placed directly onto areas prepared for reclamation, wherever possible.

RECLAMATION MATERIAL REMOVAL

Upland topsoil and subsoil are identified by ecosite class, and salvaged following clearing and drainage. Upland surface soils are divided into good, fair and poor grades, depending on the texture at the point of capture, and stockpiled according to the grade. Wherever possible, upland surface soils will be placed directly onto areas prepared for reclamation, to reduce stockpiling.

HAUL ROADS

Permanent and temporary haul roads will be built for truck haulage (see Figure 5-20). The permanent roads will provide access to the crusher and the external storage areas. Temporary roads (roads that have a life of less than one year) will be located within the active mining area and will be relocated periodically as mining progresses.

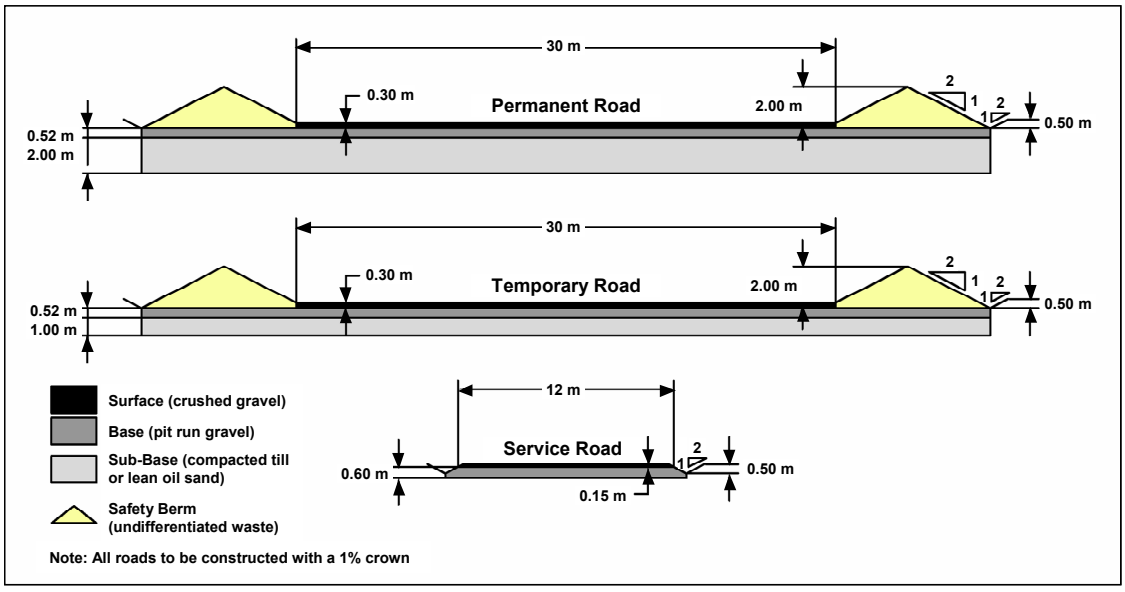


Figure 5-20: Typical Road Construction Design

Road surfacing gravel will be obtained from local suppliers. The gravel will be screened and crushed, then hauled to suitable stockpile sites at the Pierre River Mine. Wherever practical, gravel will be reclaimed from temporary mine roads as mining progresses. Road sub-base material will be available from the mine excavation.

OVERBURDEN AND INTERBURDEN REMOVAL AND OIL SANDS MINING

Overburden, interburden and oil sands will be loaded using large cable shovels. Smaller hydraulic shovels will be used where selectivity is required. Large, rear-dump trucks will haul the loaded oil sands to the crushers, where the lump size will be reduced to less than 400 mm. The oil sands will then be transported on conveyor belts from the pit to the extraction plant. The overburden and interburden material will be hauled to disposal areas or back to the pit.

Overburden and interburden disposal areas will be constructed in lifts to achieve recommended design slopes. Lift thickness, typically 10 m, will depend on the strength of the material being placed and the efficient control of surface drainage. To ensure stability, disposal areas will be closely monitored during construction, and redesigned, if necessary.

BLASTING DURING WINTER

During the winter, oil sands will freeze, causing reduced productivity and increased wear on shovels and crushers. Qualified contractors will drill and blast frozen oil sands during the winter, if necessary, to improve the efficiency of mine operations. Explosives will be transported, stored, used and disposed of by qualified third-party contractors, according to the appropriate provincial and federal regulations.

IN-PIT TAILINGS DYKE CONSTRUCTION

The construction of in-pit tailings dykes with overburden and interburden material will require on-site engineering and supervision. Dyke construction will include:

- truck haulage
- fill material placement by bulldozers and graders
- compaction

MAJOR MINE EQUIPMENT

Both 55 m^3 electric cable shovels and 35 to 40 m^3 hydraulic shovels will be used to load ore and waste. Combining two types of loading units provides:

- additional mining flexibility to meet ore delivery requirements
- the ability to maximize loading unit productivity under specific pit conditions

Large, high-productivity cable shovels will be used, whenever possible. These units operate in areas where a mining face consists of a single material type, either ore or waste. Smaller hydraulic shovels work in areas where cable shovels operate at reduced productivity levels. These are areas where selective mining is required to provide blending capabilities, or where the operating bench height is reduced because of the geological environment or pit design.

MAJOR MINE EQUIPMENT (cont'd)

Table 5-13 lists the fleet size for major equipment for the Pierre River Mine.

Table 5-13: Pierre River Mine Major Equipment Fleet Size

Equipment	2018 to 2020	2021 to 2023	2024 to 2039
Cable shovels	4	8	10
Hydraulic shovels	2	3	4
Trucks (363 t)	16	39	49
Bulldozers (large track-type)	6	13	16
Graders	2	5	6
Water trucks	1	1	2

CONTRACTOR ACTIVITIES

Activities that support the mine operation during production are generally done on a contract basis to realize cost efficiencies and to use specialty services that are not required regularly or are not considered key operating functions of the mine.

Common activities assigned to contractors include:

- clearing trees
- draining and removing muskeg
- hauling reject for disposal
- drilling and blasting
- drilling and sampling the oil sands

SCOPE

For the decommissioning status, see Figure 5-21, and for the final closure and drainage plan, see Figure 5-22.

The arrangement of in-pit tailings cells, their final elevations and filling sequence has been designed to meet the objectives of the final closure drainage plan. Placing variable depths of overburden capping material onto in-pit cells, in conjunction with sand capping specific in-pit cells, provides the required closure landscape. Final contouring of the capped tailings cells allows sustainable drainage patterns to develop, which eventually drain into the pit lakes. At the end of mining, overburden capping of in-pit tailings Cells 1, 2 and 4 is required to achieve closure drainage objectives.

Several landscape features and activities related to the Pierre River Mine development area were incorporated into the final closure drainage plan, including:

- incorporating two pit lakes into the closure landscape
- sand capping appropriate in-pit tailings cells, as opposed to overburden capping
- transferring mature fine tailings (MFT) and thin fine tailings (TFT) from the ETDA to the final pit lakes

The Pierre River Mine ore processing facilities will operate until 2039. After the extraction plant site has been decommissioned, MFT will be transferred from the ETDA and Fluid Cells 1 and 2. A portion of the MFT will be transferred from the in-pit clarification cells to provide the necessary volume of water in the pit lakes to support the closure plan.

The perimeter of the ETDA is scheduled for reclamation before 2039, and the remainder will be progressively reclaimed between 2039 and 2049. A wetlands area is located at the most northeasterly point of the ETDA to receive pumped drainage water from the west side of the structure. The ETDA will be reclaimed at the end of mine operations, during which time MFT will be transferred to the pit lakes.

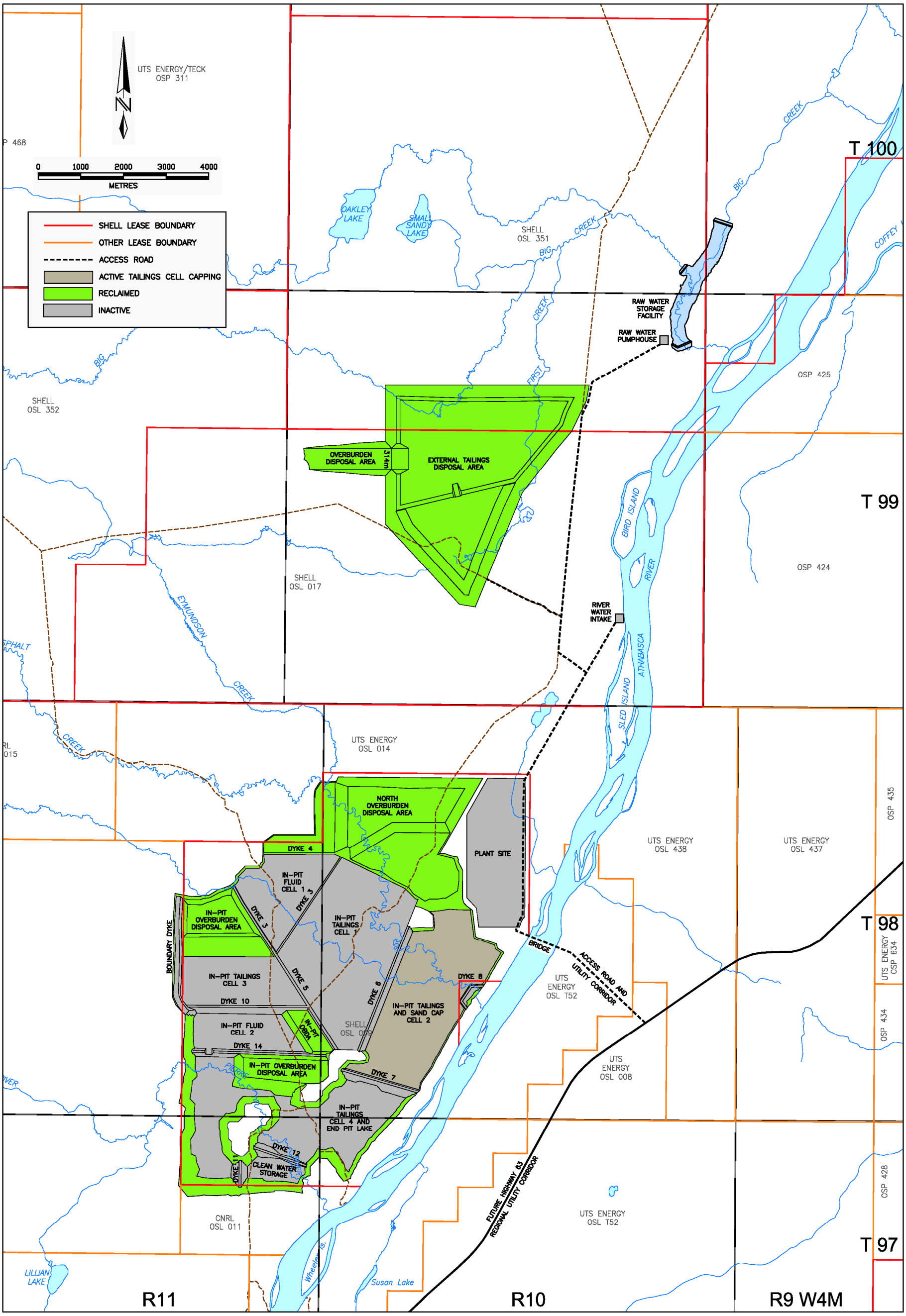


Figure 5-21: Pierre River Mine Decommissioning Status

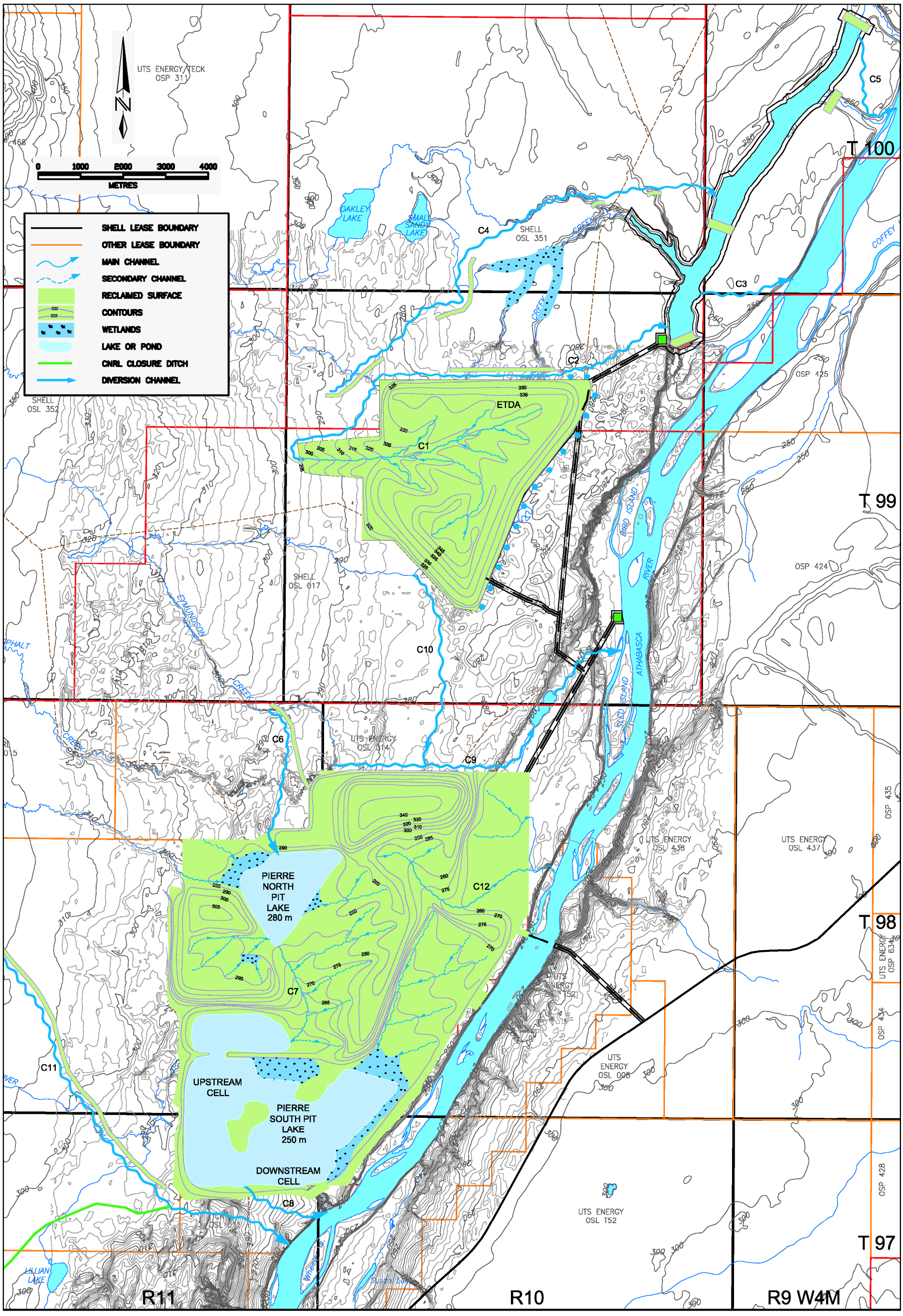


Figure 5-22: Pierre River Mine Final Closure and Drainage Plan

PROCESS DESIGN BASIS

Knowledge gained from five years of operations at the Muskeg River Mine oil sands processing facilities has provided key input for selecting the process design for the Pierre River Mine.

The selection of the bitumen extraction process for the Pierre River Mine was based on producing a diluted bitumen product that meets pipeline specifications, downstream processing and market requirements. At the same time, the process and facilities will:

- provide a safe operating environment
- use existing proven technologies and, where appropriate, enhancement to improve efficiency
- produce a high-quality bitumen product suitable for a range of upgrading processes
- meet or exceed bitumen recoveries according to the EUB's Interim Directive (ID) 2001-7

ORE PROCESSING AND TREATMENT

Major Features

The Pierre River Mine ore-processing steps (see Figure 6-1) will include:

- high-capacity ore preparation systems for oil sands sizing and slurry preparation
- slurry transportation and conditioning systems
- a warm-water bitumen extraction process
- a high-temperature paraffinic froth treatment process for bitumen cleanup
- tailings solvent recovery systems
- tailings handling and deposition systems

Major Features (cont'd)

- bitumen product solvent recovery and storage systems
- asphaltene recovery and cogeneration
- supporting utilities

The Pierre River Mine process will consist of two 15,900 m^3/cd (100,000 bbl/cd) trains. Equipment sizes and capacities that either are already commercially proven or that represent a low and acceptable technical risk have been considered.

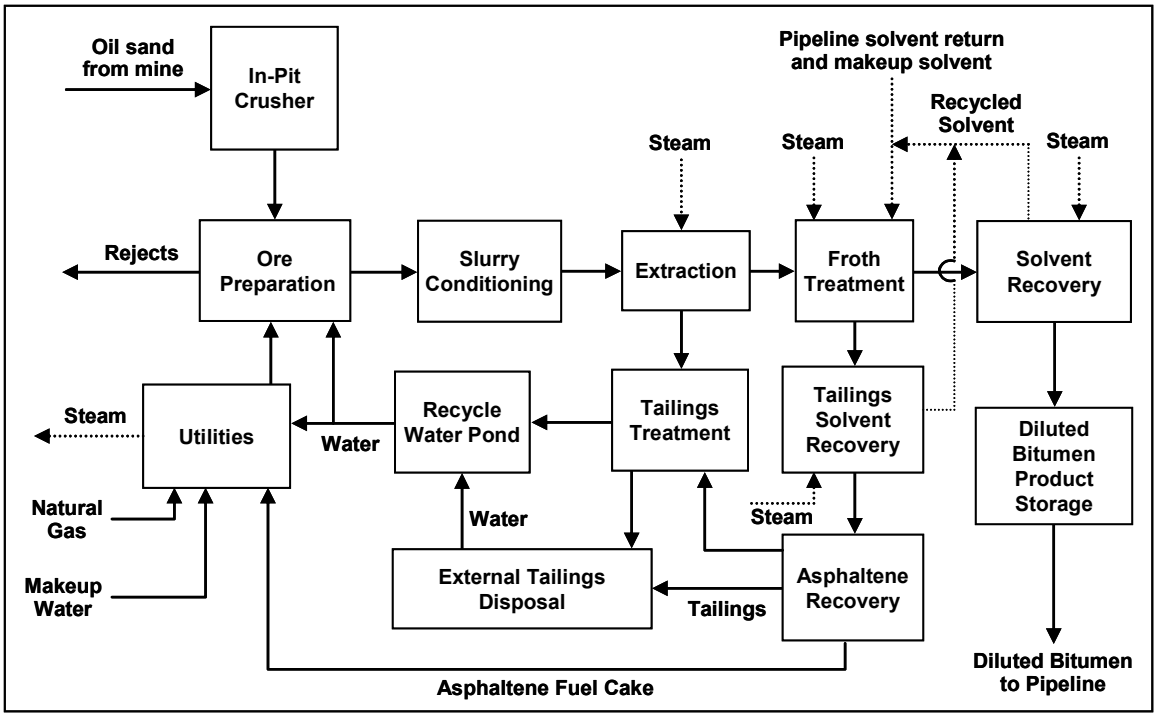


Figure 6-1: Ore Processing Flow

High-Capacity Ore Feed and Size Reduction Systems

Each train will have a high-capacity ore feed and size reduction system that matches a large-scale truck-and-shovel mining operation. The ore feed system will comprise two relocatable double-roll crushing plants. The crushing plants will reduce the size of the mined oil sands to less than 400 mm for transportation by conveyor to a surge bin.

Oil Sands Slurry Preparation and Conditioning Systems

In each train, the oil sands slurry preparation system will use four rotary breakers, in parallel, to further reduce the size of the recovered oil sands to less than 50 mm. Each breaker will have a rated capacity of 7,000 t/h. Heated water

will be added to the rotary breaker feed chutes and underflow pump boxes to slurry the oil sands before conditioning.

The oil sands slurry will be conditioned using proven pipeline conditioning technology. Two 3-km-long conditioning pipelines, each with a rated capacity of 9,300 t/h, will be provided.

Warm-Water Primary Extraction Process

The warm-water primary extraction process will be carried out in two parallel trains. Each train will include:

- one 30-m-diameter primary separation cell (PSC)
- eight 160 m^3 primary flotation cells
- twelve 160 m^3 secondary flotation cells

The process will operate at between 40 and 50°C, consistent with the existing operation at the Muskeg River Mine. The use of large PSCs and flotation cells at the Muskeg River Mine has demonstrated that recoveries that meet EUB guidelines can be achieved.

The energy efficiency of the process will be significantly enhanced by:

- recovering warm process water from the extraction tailings streams by thickening fine tailings

- using integrated heat exchange extensively throughout the process facilities

High-Temperature Paraffinic Froth Treatment Process

Froth produced from primary extraction will be cleaned in a froth treatment plant. A 70°C paraffinic solvent will be used to remove the water and solids from the bitumen froth. The process will consist of two counter-current decantation (CCD) trains in series.

This process was extensively piloted by Shell and builds on the operating experience of the lower temperature froth treatment process at the Muskeg River Mine. The bitumen produced from this process will contain low levels of solids and water that are comparable to those produced by the low-temperature paraffinic froth treatment process.

Solvent Recovery and Recycle Systems

Solvent from the froth treatment process that exceeds the amount required for transporting bitumen by pipeline, will be removed from the diluted bitumen (dilbit) product by flash vessel and recovered in condensation drums in the product solvent recovery unit. The diluted bitumen product, containing about 32 wt% solvent, will have a viscosity low enough to enable the dilbit to be transported to the product storage area and, ultimately, to a downstream upgrader by pipeline.

Solvent Recovery and Recycle Systems (cont'd)

A tailings solvent recovery unit (TSRU) will remove residual solvent in the solids from froth treatment tailings. Two TSRU vessels, operating in series, the first using elevated temperature and pressure, and the second incorporating partial vacuum stripping, will be used to remove solvent from the froth treatment tailings. This will produce a TSRU tailings stream that will be processed in the asphaltene recovery process.

The solvent recovered from both solvent recovery unit and TSRU will be recycled back to the solvent storage facilities for reuse in the froth treatment process.

Tailings Treatment

Tailings from the extraction and froth treatment processes will be handled separately.

Extraction tailings from the PSC will be treated in a secondary flotation process to recover any residual bitumen. Flotation tailings will be separated into coarse and fine sand streams, using cyclones. The coarse sand from the cyclone underflow will be pumped to the ETDA for use in dyke construction. Fines sand from the cyclone overflow will be thickened in large diameter high-rate thickeners. The thickened fine tailings will be disposed of into the ETDA. Warm water recovered from the tailings thickener will be recycled to the extraction plant.

Asphaltene Recovery

Tailings from the TSRU will be treated in the asphaltene recovery plant. An asphaltene-rich concentrate will be used as a primary boiler fuel to provide process heat. The sand-rich tailings will be pumped to the ETDA to provide process heat.

BASIS

The process scheme for the Pierre River Mine will be similar to that successfully used at the Muskeg River Mine. The scheme will consist of a combination of processes that have been proven at the mine or demonstrated through research or pilot plant testing.

An average oil sands feed grade of 10.9 wt% bitumen has been assumed in the design and sizing of the process facilities. The process facilities have a design capacity of 31,800 m^3/cd (200,000 bbl/cd) of bitumen.

ORE PREPARATION AND SLURRY CONDITIONING

Ore Preparation

The Pierre River Mine ore preparation system (see Figure 6-2) will consist of two trains. Each train will include:

- two 14,000 t/h double-roll crushers
- a surge conveyor
- a dry surge bin
- two reclaim apron feeders
- two breaker feed conveyors
- two rotary breakers
- a rejects handling system

Two apron feeders, located beneath the surge bin, will reclaim the crushed ore and discharge it onto two breaker feed conveyors that feed directly to two rotary breakers.

Oil sands will be withdrawn from the surge bins and fed to the ore preparation system where the lumps will be reduced further in rotary breakers.

Heated water will be added to the rotary breaker slurry feed chute and, together with the tumbling action inside the breaker, will slurry the oil sands and separate the coarse sand from the fine material by screening, to a maximum lump size of 50 mm. The slurry will pass through perforations in the shell and be collected in pump boxes. Waste rock and other lumps too large to pass through the perforations will be rejected at the far end of the rotary breaker.

Ore Preparation (cont'd)

Oversize material from the rotary breakers will be discharged onto a conveyor that will transport the rejects to a truck-loading bin. Mine trucks will remove the reject material to the mine disposal area.

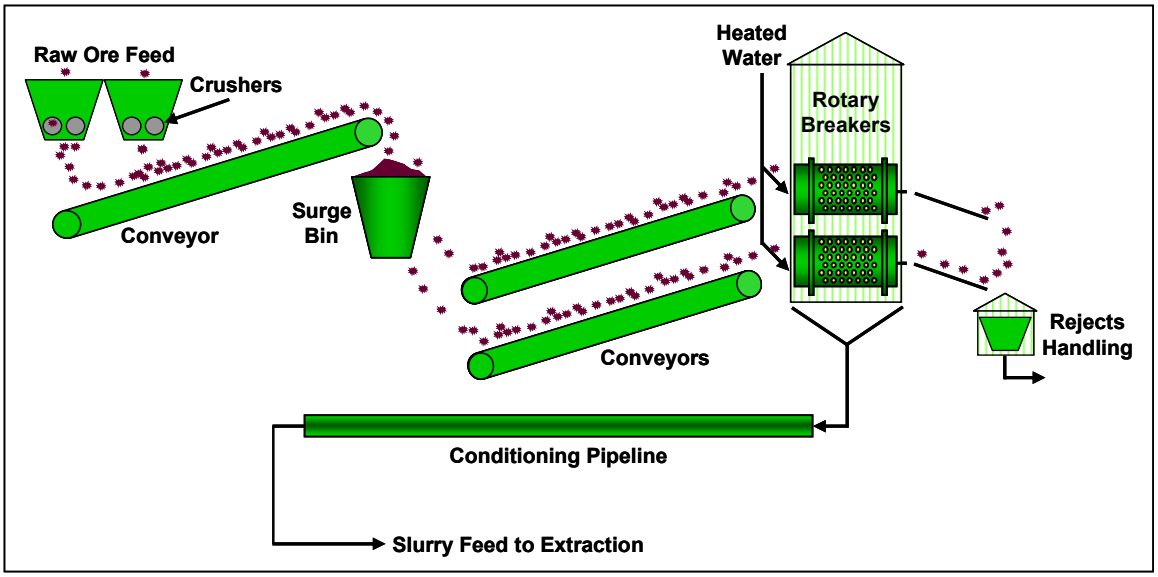


Figure 6-2: Ore Preparation and Slurry Conditioning Flow Diagram

Slurry Conditioning

Oil sands slurry from the two rotary breakers will be pumped via a 3-km-long, conditioning line to the extraction plant.

The slurry conditioning process will prepare the oil sands for the extraction process by:

- ablating lumps from 50 mm to less than 2.4 mm through process heat, mechanical shear energy and residence time
- providing time for the release and mixing of natural surfactants, which enhances the separation of bitumen from mineral solids
- providing air entrainment and mixing to encourage air to attach to the bitumen
- providing for the addition of a chemical reagent to enhance bitumen separation of low-grade, high-clay fines or poorly processing ore

PRIMARY EXTRACTION PROCESS

The Pierre River Mine primary extraction process (see Figure 6-3) will consist of:

- a primary separation cell
- a series of primary flotation cells
- a froth deaerator
- froth screening

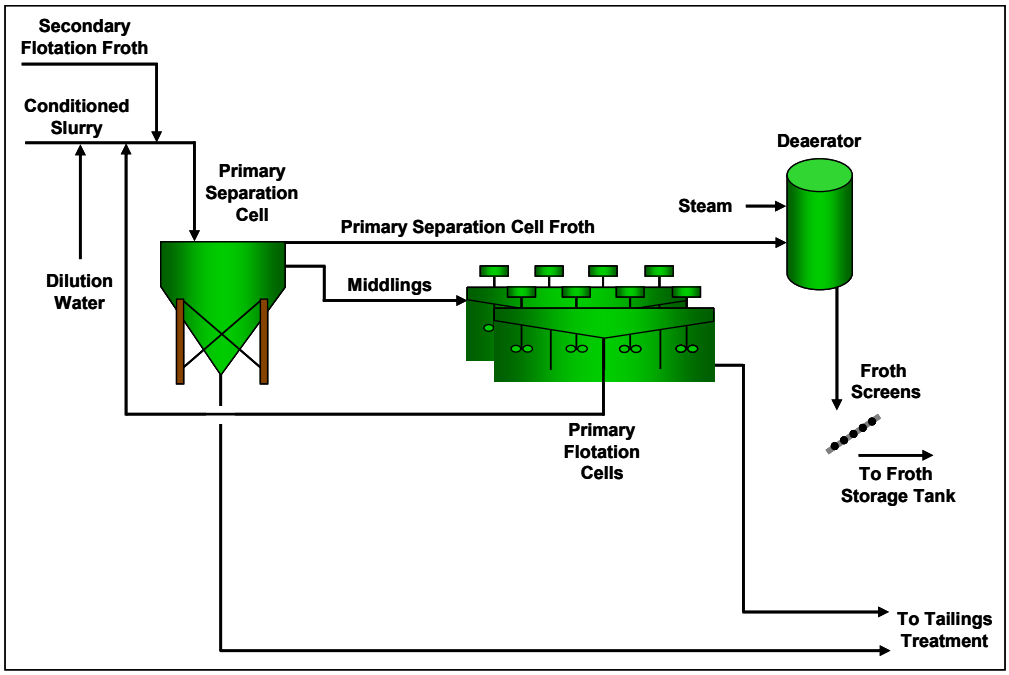


Figure 6-3: Pierre River Mine Primary Extraction Process Flow Diagram

Conditioned oil sands from the ore preparation process will be fed into the two primary separation cells. Each cell will be 30 m in diameter with a 55° conical base, similar to those used for the Jackpine Mine. In each primary separation cell, aerated bitumen will be separated from the sand by gravity and will float to the surface as froth, containing:

- bitumen
- water
- fine sand and clay particles
- air

Most of the coarse sand will settle to the bottom of the primary separation cells, where it will be removed for further treatment to recover bitumen.

Middlings Stream

A middlings stream will be taken from the primary separation cell and further processed in a series of primary flotation cells to recover additional bitumen that did not float into the primary separation cell froth. These primary flotation cells will be mechanically agitated and air added to recover the bitumen from fine sand and clay particles.

Middlings Stream (cont'd)

The bitumen froth from primary flotation will be recycled and reintroduced into the primary separation cell. Part of the tailings from the flotation cells will be reinjected into the primary separation cell to maintain fluid density. The remaining portion of the primary flotation tailings, together with the underflow from primary separation cell, will flow to the final stage of bitumen recovery in the tailings treatment process.

Froth Composition and Treatment

The composition of the froth from the primary separation cell will vary, and is expected to contain between 50 and 60 wt% bitumen. The froth from the primary separation cell will be deaerated to release entrapped air by increasing its temperature in a direct-contact steam deaerator.

The deaerated froth will be processed in a series of linear screens to remove trash and solid organic material that could interrupt froth treatment processes or control systems. Trash rejects will be removed, stored in bins and periodically transported to the on-site industrial landfill. Screened and deaerated froth will be pumped to a froth storage tank in either of the two trains.

TAILINGS TREATMENT AND PROCESSING

The Pierre River Mine tailings treatment plant (see Figure 6-4.) will consist of:

- a scalping screen
- tailings flotation cells
- cyclones
- a fine tailings thickener
- a tailings disposal system

The coarse sand underflow from the PSC train will be pumped to vibrating screens where large solids will be removed. The screen underflow will be combined with the primary flotation cell tailings and then pumped to tailings bitumen flotation cells, similar to those used to process the primary separation cell middlings stream. Froth from these flotation cells will be fed back to the primary separation cell.

Tailings from tailings flotation cells will be pumped through a number of cyclones, where the tailings feed will be distributed into fine and coarse particle sizes. The cyclone underflow stream will have an increased density of coarse solids and reduced fines content.

The coarse tailings from the cyclone will be pumped to the ETDA. Once in-pit disposal of tailings starts, the coarse tailings will be combined with thickener underflow and gypsum to produce a non-segregating tailings (NST) mixture.

The cyclone overflow, which contains water, fine solids and residual bitumen, will flow to a high-rate thickener. Warm thickener overflow water will be

recovered and recycled to extraction facilities. Thickened tailings will be pumped to the ETDA, until they are used for producing NST.

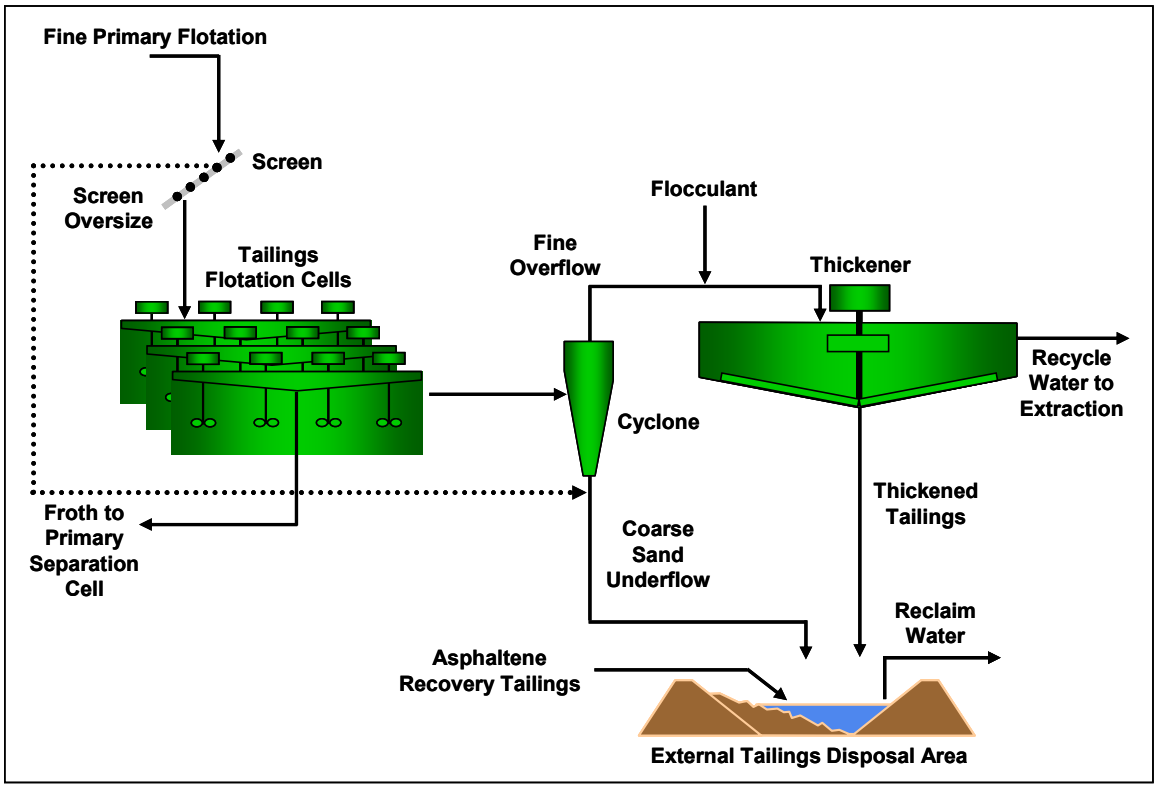


Figure 6-4: Pierre River Mine Tailings Treatment Process

NON-SEGREGATING TAILINGS DISPOSAL

Mineral solids from oil sands processed through extraction and tailings handling facilities will eventually be transported as non-segregating tailings slurry to in-pit cells. Tailings disposal in in-pit cells will consist of four tailings streams:

- coarse tailings
- thickened tailings
- non-segregating tailings
- asphaltene recovery process tailings

Non-segregating tailings and the asphaltene recovery process tailings will be pumped to the in-pit cells for disposal. The final 5 to 10 m of in-pit cells will be sand capped with coarse tailings. During sand capping, thickened tailings and the asphaltene recovery process tailings will be pumped into the next available in-pit cell.

HIGH-TEMPERATURE PARAFFINIC FROTH TREATMENT

The Pierre River Mine froth treatment train will use a high-temperature paraffinic froth treatment process. The froth treatment process (see Figure 6-5) will consist of:

- a froth storage tank
- a two-stage high-temperature CCD process
- a vapour recovery unit

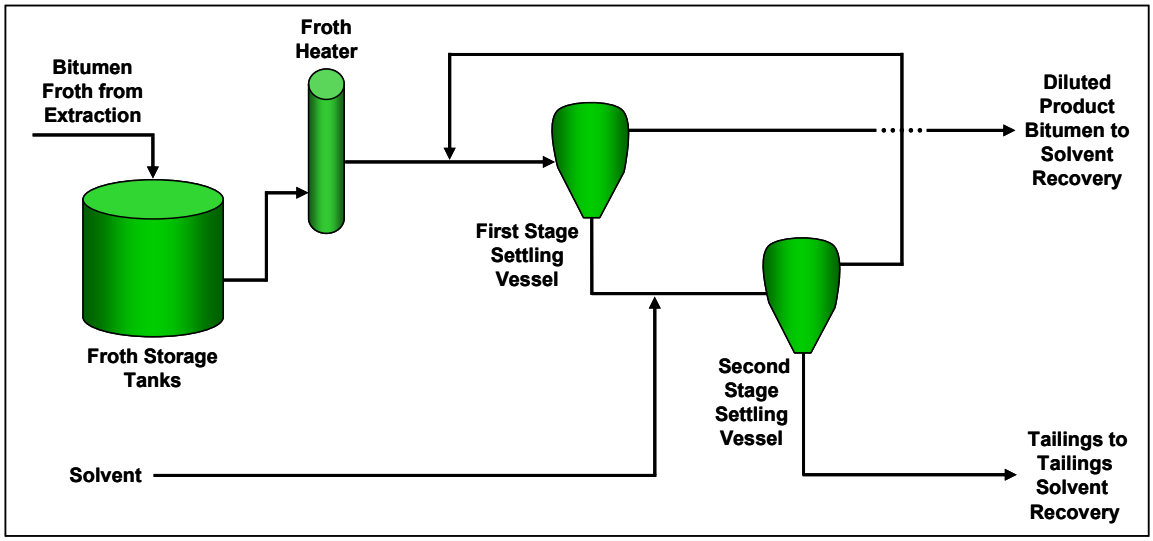


Figure 6-5: Froth Treatment Process Flow Diagram

The high temperature CCD process will consist of a first-stage settling vessel and a second-stage settling vessel operating in series at 70ºC. Bitumen froth from the froth storage tank will be heated then pumped to the CCD, where it will be mixed with the overflow from the second-stage settling vessel before entering the first stage settling vessel. The second-stage overflow will run through a heater to control the temperature in the first-stage settler.

Bitumen normally contains about 17 wt% asphaltenes. The mixing of froth and second-stage overflow will be controlled to give a specific product solvent-to-bitumen (S:B) ratio from the first-stage vessel. This will cause a large portion of the asphaltenes to precipitate, leaving the product bitumen with an asphaltene content of about 9%.

Clean bitumen will be removed as the first-stage overflow and pumped to the solvent recovery unit. The underflow from the first stage will be processed in the second stage to recover additional bitumen. The underflow from the second-stage settler will be pumped to the TSRU.

The first stage will produce clean, dilute bitumen. The overall deasphalted bitumen recovery will be about 99%.

Natural gas will be used as a blanketing agent within the settling vessels.

SOLVENT RECOVERY

Solvent Recovery Unit System

The Pierre River Mine solvent recovery unit will be two trains designed to partially recover solvent contained in the diluted bitumen product from the first-stage settling vessel overflow of the high-temperature froth treatment process. Each solvent recovery unit will consist of:

- a feed heater
- a flash column
- an overhead system
- product coolers

The diluted product from froth treatment will be heated to vaporize the solvent before it enters the flash column. The overhead vapour from the column will be condensed. Recovered solvent will be recycled to froth treatment. The remaining solvent, about 28 to 32% by volume, will remain with the bitumen product to enable the bitumen to be transported by pipeline. The dilbit from the solvent recovery unit column (see Figure 6-6) will be cooled through recycle water/dilbit coolers before flowing to the dilbit storage tank for subsequent transportation by pipeline.

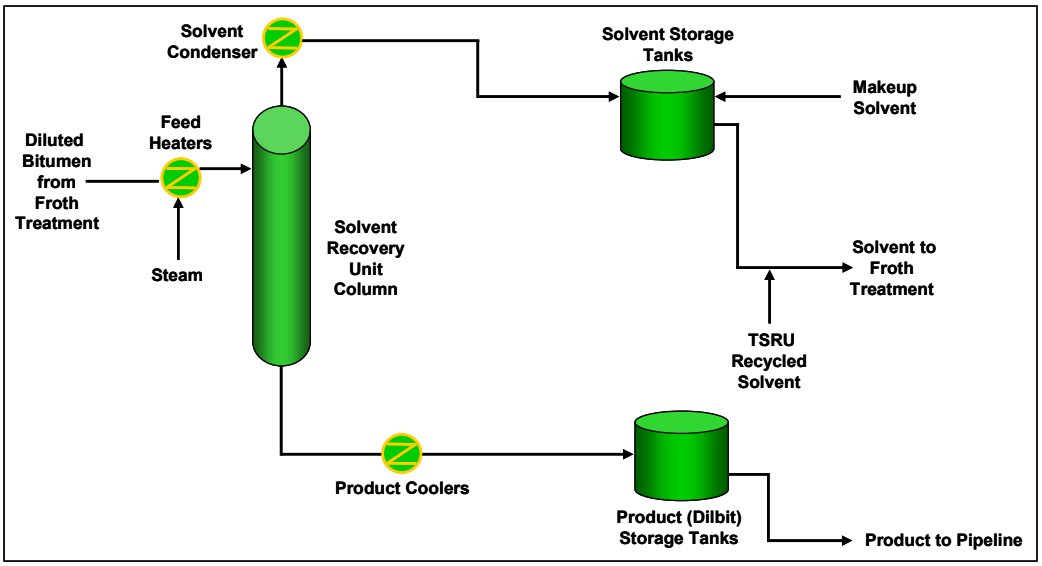


Figure 6-6: Solvent Recovery Unit Flow Diagram

Tailings Solvent Recovery Unit System

The Pierre River Mine TSRU system will consist of two stages of separation columns in series. Froth treatment tailings will be heated by direct steam injection to strip the solvent from the solids slurry in the first-stage column for further solvent recovery. Tailings from the first-stage column will be injected into the second-stage column, which will be operated under a partial vacuum (see Figure 6-7).

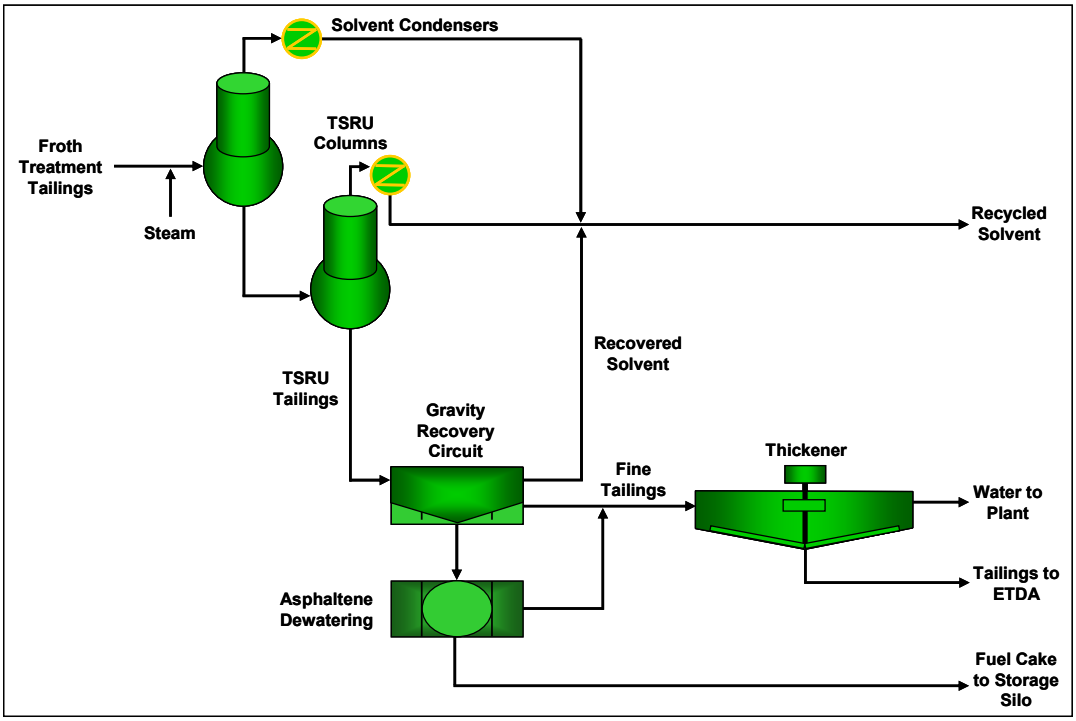


Figure 6-7: Tailings Solvent Recovery Unit Flow Diagram

Makeup Solvent

Makeup solvent for the process will be provided from the downstream operations. Makeup solvent includes the solvent used to enable pipeline transmission of the product and any losses from the process.

Solvent from both columns will be condensed in an overhead system and recycled back to the froth treatment process. Tailings will be pumped to the asphaltene recovery unit for processing.

Solvent recovery from the TSRU will be in excess of 99%. The residual solvent loss will meet or exceed the EUB target of four volumes of solvent per 1,000 volumes of dry bitumen production.

The TSRU system will be operated so that no untreated TSRU tailings are sent to the tailings pond.

The TSRU tailings from the Pierre River Mine will be processed in an asphaltene recovery process to produce a fuel cake for combustion in an asphaltene-fired boiler.

Asphaltene Recovery Process

Using asphaltenes as a fuel for steam generation provides an opportunity to eliminate the need for natural gas as a combustion fuel. Additional benefits of the asphaltene recovery process are that it:

- further reduces solvent loss to tailings for reuse in the process
- recovers warm water to further reduce the overall plant energy intensity

The asphaltene recovery process separates asphaltenes, water, mineral solids and solvent in the TSRU tailings. The process consists of the following units:

- gravity separation
- asphaltene dewatering
- tailings thickening and water recovery
- solvent recovery

The TSRU tailings will be treated in a gravity separation unit, where the mineral solids will be separated from the asphaltenes. Free solvent in the feed will be recovered in a vapour recovery unit and pumped back to the froth treatment plant. The asphaltene-rich stream will be dewatered to form fuel cakes and transferred to the asphaltene storage silos. Water recovered from the dewatering process will be combined with the gravity separation tailings and thickened in a high rate thickener. The thickener underflow will be pumped to the tailings facility. The recovered warm water will be returned to the extraction process plant.

The recovered fuel cake will be used in the asphaltene-fired boiler located in the cogeneration plant (see Section 8, Utilities and Infrastructure).

FINAL PRODUCT BITUMEN AND SOLVENT STORAGE

Product Bitumen Tankage Facilities

The final product bitumen tankage facilities will consist of:

- two storage tanks
- a pipeline feed pump, plus a spare pump
- a recycle pump
- an oily water collection system

Diluted bitumen product from the solvent recovery units will flow through an interconnecting underground pipeline to one of the two storage tanks. Each storage tank will have:

- a working capacity of 47,800 m^3, equivalent to one day of bitumen production at 31,800 m^3/cd, with a solvent content of 32 vol%
- an internal floating roof to control volatile organic compound emissions
- a secondary containment consisting of liners and dykes

If the diluted bitumen product is off-specification, a recycle pump will transfer the diluted bitumen back to the froth treatment plant for reprocessing.

Solvent Tankage Facilities

The Pierre River Mine solvent tankage facilities will consist of:

- a storage tank
- a return pump, plus a spare pump

Recycled solvent will flow directly into the solvent storage tank. The tank will have:

- a working capacity of 41,900 m^3, equivalent to 2.8 days of bitumen production at 31,800 m^3/cd, with a solvent content of 32 vol%
- an internal floating roof to control volatile organic compound emissions
- secondary containment, consisting of liners and dykes

RELIEF AND BLOWDOWN SYSTEM

During normal operations, solvent vapours from within froth treatment, the solvent recovery unit and the TSRU will be collected in a vapour recovery unit. Condensed solvent will be returned to solvent storage. Non-condensable solvent will be used as supplementary fuel in the steam generators at the cogeneration plant. A relief and blowdown system will be installed to collect and dispose of any additional solvent vapours that might be generated during a process upset, or during plant start-up and shutdown operations. The system will consist of a flare gas collection system and low-pressure elevated flare, and will accommodate loads from froth treatment, the solvent recovery unit and the TSRU.

HYDROCARBON CONTAINMENT SYSTEMS

During normal operations, hydrocarbon liquids will not be released from process piping or process equipment. Releases that could occur during maintenance activities that require equipment or piping to be opened, will be minimized by standard operating practices, such as purging and gas freeing. Collection and containment systems will be provided to ensure that no hydrocarbon liquids will be released outside of the process area. Hydrocarbon liquids entering these systems will ultimately be recycled to the appropriate point in the process.

BITUMEN RECOVERY

Extraction recovery is dependent on the quality of feed from mining operations (see Table 6-1 for the expected average process recovery at an average feed grade of 10.9 wt% bitumen). The expected recovery at the average plant feed grade will meet the recovery requirements set out in EUB Interim Directive 2001-7.

The rejected material from froth treatment will consist of fine solids and water, together with precipitated asphaltenes and a small quantity of bitumen. Precipitating asphaltenes is a key element of the paraffinic froth treatment process to achieve a clean bitumen product that consistently meets pipeline specifications and provides good-quality feed for further upgrading.

Table 6-1: Bitumen Recovery from Average-Grade Oil Sands

Process Step	Bitumen Recovery (%)	Cumulative Bitumen Recovery (%)
Ore preparation and slurry conditioning	98	98
Extraction and tailings	93	91
Froth treatment and maltene losses	99	90
Froth treatment total	89	81
Note: Extraction recovery, including rejects, and froth treatment recovery, including only maltene losses.		

PRODUCT QUALITY

The final bitumen in the diluted bitumen product from the Pierre River Mine will contain less than 800 ppm solids, less than 0.05% water and about 9% asphaltene. The diluted bitumen product ready for shipping will contain, on average, 32% solvent by volume, and the amount of solvent will vary, depending on the season.

SCOPE

The warm water extraction process will produce three tailings streams:

- a coarse slurry stream from the cyclone underflow, consisting predominantly of water and sand
- a thickened tailings stream from the thickeners, consisting mostly of fine tailings (silts and clays)
- tailings from the tailings solvent recovery unit (TSRU), consisting of fines, rejected asphaltenes and a small amount of residual solvent

From the start-up of the Pierre River Mine operation in 2018, tailings will be deposited in an external tailings disposal area (ETDA). All tailings will continue to be deposited in the ETDA until 2029 when the first in-pit cell will be available. An in-pit transition period of two to three years is planned during which decreasing amounts of tailings will be deposited in the ETDA. The transition will be completed to a 100% in-pit tailings deposition by the end of 2029.

EXTERNAL TAILINGS DISPOSAL AREA

The proposed ETDA (see Figure 7-1) covers 1,585 ha and will have a capacity of 620 Mm^3 of tailings. The final dyke height will be 336 m.

The initial starter dyke will be constructed from overburden. Then the dyke for the ETDA will be constructed of coarse tailings. In the main tailings area, the dyke will be beached to the interior to produce a broad, stable structure. Coarse tailings will be discharged into settling cells on top of the dyke to raise elevations. Figure 7-2 shows the conceptual construction for the ETDA.

The coarse tailings stream will undergo segregation settling when deposited on the beaches or into the cells. Sand will quickly settle on the beaches or in the cells. A dilute silt and clay slurry of thin fine tailings (TFT) will flow into the main tailings area water. The fines will settle from the water, and the clarified water will be recycled to the extraction process. The fine solids will ultimately thicken and settle to a mature fine tailings (MFT) layer.

The thickened tailings (TT) stream will be non-segregating and will be deposited separately into the TT area contained by the coarse tailings dykes.

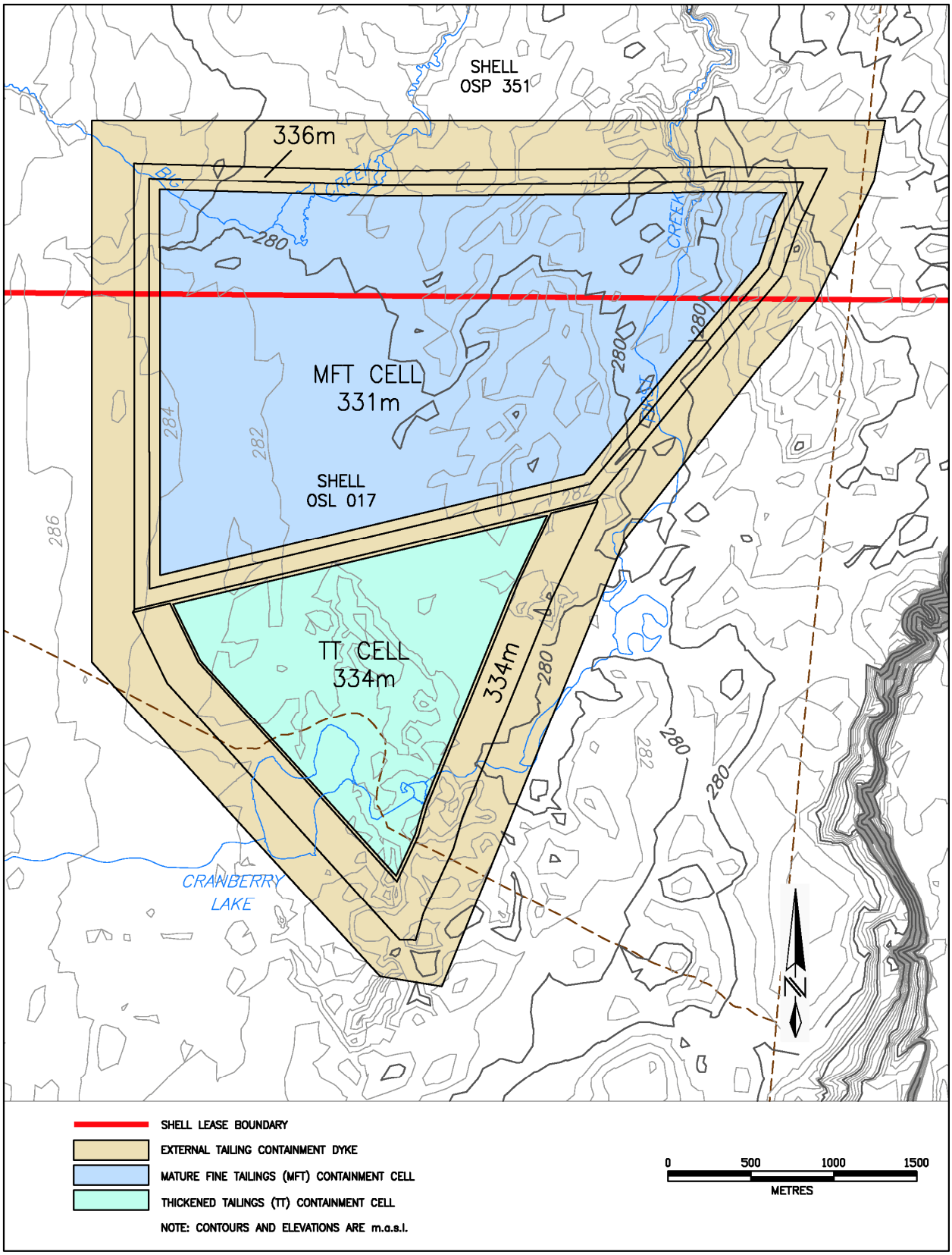


Figure 7-1: Final Configuration of External Tailings Disposal Area

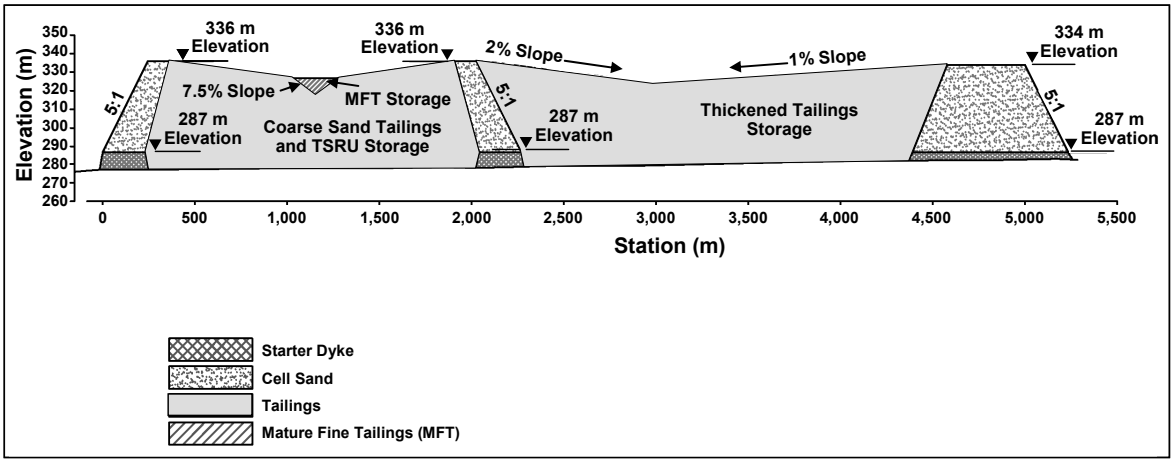


Figure 7-2: External Tailings Disposal Area Construction Concept

Siting

Different potential disposal areas were evaluated. The site required the capacity to store a minimum of 620 Mm^3 of tailings, which would require an area of about 11 km^2. The Lease 9 site had no available space to handle an ETDA of this size. Therefore, the ETDA was located on Leases 17 and 351 in an area where preliminary drill holes indicated a lack of economic oil sands. The ETDA was also located 1.6 km from the Athabasca River to reduce potential seepage effects.

The ETDA will be segmented into two storage areas:

- the TT storage area for the TT stream
- the main tailings area for the coarse slurry and TSRU tailings streams

NST IN-PIT TAILINGS DISPOSAL

In 2029, the first mine pit area will be available to receive tailings. To avoid a continual buildup of fine tailings, the fines will be incorporated into the coarse sand deposit. This will be done using a non-segregating tailings (NST) process. The thickened tailings will be mixed with coarse dewatered sand in the extraction plant, and gypsum will be added to produce a non-segregating mix for deposition in the mine pit. Over several years, the NST deposits will consolidate and increase in strength. The excess TFT will be stored in separate in-pit clarification cells.

Near the end of the mine life, the main tailings area of the ETDA will be dredged of mature fine tailings (MFT), refilled with coarse tailings and reclaimed. The dredged MFT and TSRU tailings will be deposited into the end-pit lake. The TT will remain in place and will not be moved. Drainage will be established in an end-pit lake after mining operations end and reclamation is established according to the approved plan (see Section 7.7, Reclamation Approach).

The in-pit tailings layout (see Figure 7-3) shows the in-pit dykes and cells that will be required over the mine life. These in-pit cells will contain cumulative tailings of about 1,178 Mm^3.

CONSOLIDATED TAILINGS DEPOSITION

Consolidated tailings deposition into the pit has been planned as a two-cell operation with one active NST cell and one active clarification cell. During NST deposition and off-specification NST system operation, some TFT will be released that will accumulate in the NST pond, suspended in water. The TFT will be removed continually from the active NST deposition cell by pumping to the in-pit clarification cell. A portion of the TFT from the in-pit clarification cell will be recombined into the NST stream to improve fines capture performance.

The seven in-pit cells created when the area is mined will be used for tailings disposal as follows:

- three deposition cells to store NST material
- two in-pit clarification cells to store the TFT fluids generated from the NST deposition. At closure, these two cells will be converted to a pit lake, or an end-pit lake, and the MFT fluids remaining in the cells will be capped with water.
- one end-pit lake cell to accommodate final MFT transfers
- one end-pit lake clean water cell, free of tailings

VOLUME OF TAILINGS

For the Pierre River Mine, the total volume of tailings produced for in-pit storage from 2029 to 2039, will be 893 Mm^3. This will include:

- 145 Mm^3 of TFT
- 561 Mm^3 of tailings solids
- 175 Mm^3 of coarse sand tailings (CST) cell caps
- 12 Mm^3 of MFT transferred from the ETDA

An estimated 16 Mm^3 of TFT can be incorporated in the NST stream. This will reduce the volume of MFT to 141 Mm^3, for a total of 877 Mm^3 of tailings stored.

FINAL TAILINGS DEPOSITION

During decommissioning, 104 Mm^3 of MFT will be dredged and pumped from the ETDA to an end-pit lake. During operations, fluid Cell 2 is designed to store 40 Mm^3 of TFT below the final water elevation of the end-pit lake, so the cell will become integrated with the end-pit lake at closure. Drainage will be directed into the end-pit lake after mining operations end.

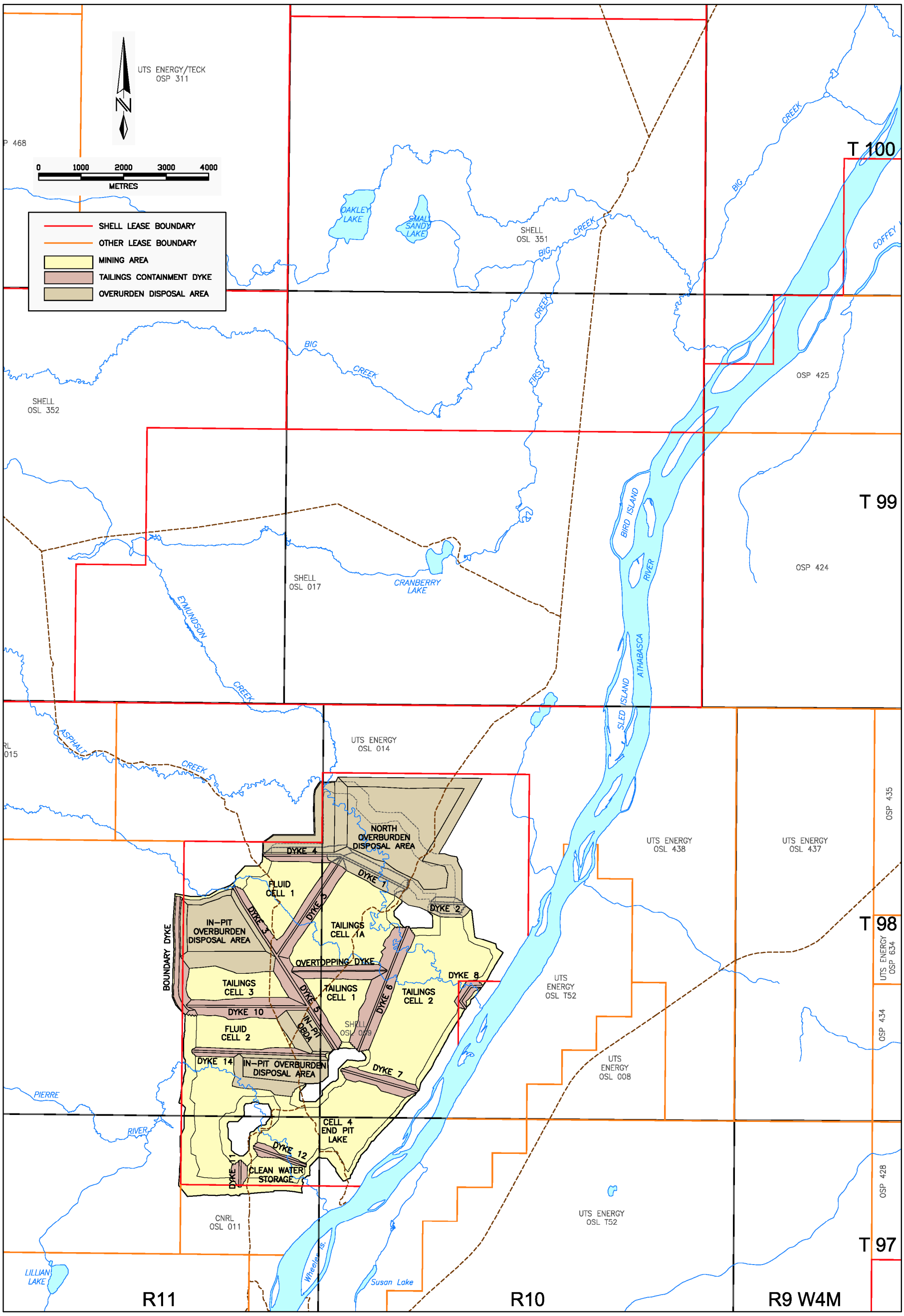


Figure 7-3: In-Pit Tailings Layout of Dykes and Cells

SCOPE

The Tailings Management Plan describes the sequencing of tailings activities and provides the material balances for the external tailings disposal and in-pit tailings operations.

OBJECTIVES

The objectives of the Tailings Management Plan are to:

- minimize external storage of tailings
- maintain mine operating flexibility
- provide a logical mine closure plan

These objectives will be accomplished by providing an available in-pit NST storage area as soon as practical.

TAILINGS STREAM PROPERTIES

During operations, two types of tailings will be produced at the extraction plant:

- conventional tailings
- non-segregating tailings

The conventional tailings produced will be grouped into three tailings streams:

- coarse sand
- thickened tailings
- TSRU tailings

Non-segregating tailings will be made by mixing coarse sand with thickened tailings, and adding gypsum as a coagulating agent.

Non-segregating tailings production will start in 2029. When the plant is producing NST, the two tailings streams produced will be NST and TSRU tailings.

Thin fine tailings (TFT) will be released during tailings deposition and will accumulate in the basin of the active tailings pond. Table 7-1 lists the estimated

TAILINGS STREAM PROPERTIES (cont'd)

deposition properties for the various tailings streams used in the mass balance model.

Table 7-1: Tailings Deposition Properties

Property	Tailings Stream				
	NST	TSRU	Coarse Sand	Thickened Tailings	TFT
Fines capture [1] • On-specification • Off-specification	 81% 67%	10%	–	70%	N/A
Transport	Hydraulic	Hydraulic	Hydraulic	Hydraulic	N/A
Discharge	Subaerial	Subaqueous	Subaerial and subaqueous	Subaerial and subaqueous	N/A
Number of discharge points	Minimum 3	1	Minimum 3	Minimum 1	N/A
Beach slopes	–	10%	2 to 7.5%	1 to 3%	N/A
Water cap	None required	3 m	None required	None required	N/A
Freeboard	3 m	3 m	3 m	3 m	3 m
Deposited dry density [2] • On-specification • Off-specification	 1.62 t/m^3 1.55 t/m^3	Mineral solids: 0.93 t/m^3	Beached: 1.51 t/m^3 Cell sand: 1.67 t/m^3	In-pit: 0.96 t/m^3 ETDA: 0.85 t/m^3	0.4 t/m^3

Note:
1. Includes fines captured in tailings and total fines.
2. Average density achieved by the deposit two years after cell filling.

EXTERNAL TAILINGS DISPOSAL OPERATIONS

The ETDA required for storing all tailings during early operations will be designed and sized to accommodate the tailings production before mine pit storage is available. The ETDA will be a segmented facility, incorporating separate areas for storing coarse sand and thickened tailings.

Mine overburden will be used to construct the initial ETDA starter dyke. This will be followed by construction with sand tailings to build a retention structure of compacted sand and beach to the full design height. The TT area of the structure will be infilled with the thickened tailings, and runoff will be collected and transferred to the main tailings area. The TT area will be required to provide storage for some thickened tailings for an additional two years after NST disposal in-pit has started and until a TT in-pit cell is available. The TT area will also be used during the initial years of operation to store TSRU tailings. Providing a separate smaller area initially will reduce water cap requirements and increase opportunities for operational monitoring of the depositional behaviour of TSRU tailings.

The main tailings area of the structure will be simultaneously infilled with TSRU tailings and TFT runoff from cell and beach construction, which will settle and allow recycle water to be reclaimed. The TFT will settle or dewater to a higher solids concentration to produce an MFT layer. The deposition of sand beaches in the ETDA will also trap and entrain a large percentage of the fine tailings.

NON-SEGREGATING TAILINGS OPERATIONS

When in-pit space contained by the overburden dykes and pit wall is available, NST production will begin (see Figure 7-4). Mixing equipment for gypsum addition will be added for NST operations. Recycle water recovery equipment and return lines from in-pit NST cells will also be installed before NST production starts.

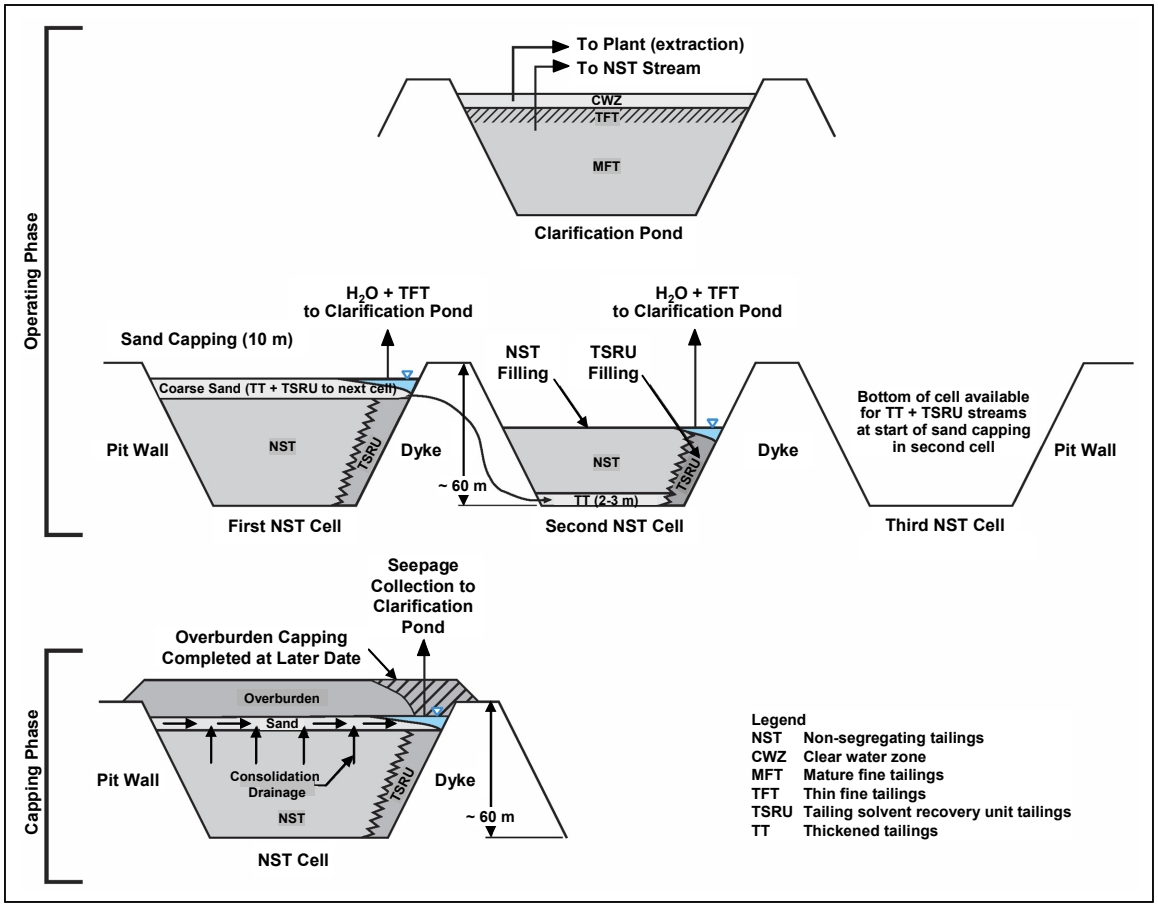


Figure 7-4: Non-Segregating Tailings Production

NST will be made by combining a portion of the TT stream with the cyclone underflow stream and gypsum to produce slurry with a sand-to-fines ratio of 5:1. The remaining TT will be disposed of in a separate in-pit cell. During deposition of NST, fluids and some fine mineral solids will be released from the NST deposits, requiring clarification and rehandling. The final stage of tailings deposition in an in-pit cell will consist of a 10-m-thick sand cap. Beaching CST

NON-SEGREGATING TAILINGS OPERATIONS (cont'd)

over the NST will place the sand cap. The TFT produced will be captured and pumped into the active clarification cell. During this operation, NST production will stop. The TT stream associated with CST production will be deposited, along with the TSRU, in the next available in-pit cell. When the 10 m sand cap of the cell is complete, NST production will resume in the next in-pit cell.

The tailings management plan accounts for normal operational disruptions by allowing for periods of off-specification NST production and lower fines capture efficiency.

SEQUENCE OF TAILINGS ACTIVITIES

The tailings management plan meets the primary objective of placing tailings into the mine pit as soon as possible to reduce the size of the ETDA.

2018 to 2028

All tailings will be deposited into the ETDA during the first 10 years of operation. A cross dyke will be constructed of CST to segment the ETDA into two cells. TT will be deposited in the south cell. Coarse sand and TSRU will be deposited in the north cell. All TFT captured will be stored in the north cell. TFT totalling 12 Mm³ will be transferred from the ETDA to fluid Cell 1 in-pit. The ETDA sequence is illustrated in:

- Figure 7-5, which shows the status at the end of 2018
- Figure 7-6, which shows the status at the end of 2028

2028 to 2033

Before in-pit filling can begin, an economically sized area of pit floor contained by both in-pit dykes and elements of the perimeter pit wall must be available.

The first in-pit cell (Cell 1) represents the minimum size within the availability of construction material for the in-pit dykes and the exposure of the pit floor dyke construction area. An overtopping dyke will be used to segment Cell 1 into two areas. This will allow the southern portion of Cell 1 to be constructed while tailings deposition begins in the northern portion of Cell 1 in 2029. The two phases of Cell 1 will contain about 414 Mm^3 of tailings and will be used for tailings disposal for seven years. Cell 1 will be the first in-pit cell containing NST, and all TFT will be pumped to fluid Cell 1.

Fluid Cell 1 will begin receiving TFT in 2028. It will include a reclaim water system and an MFT barge harvest system. All TFT will be transferred to fluid Cell 1 in this period.

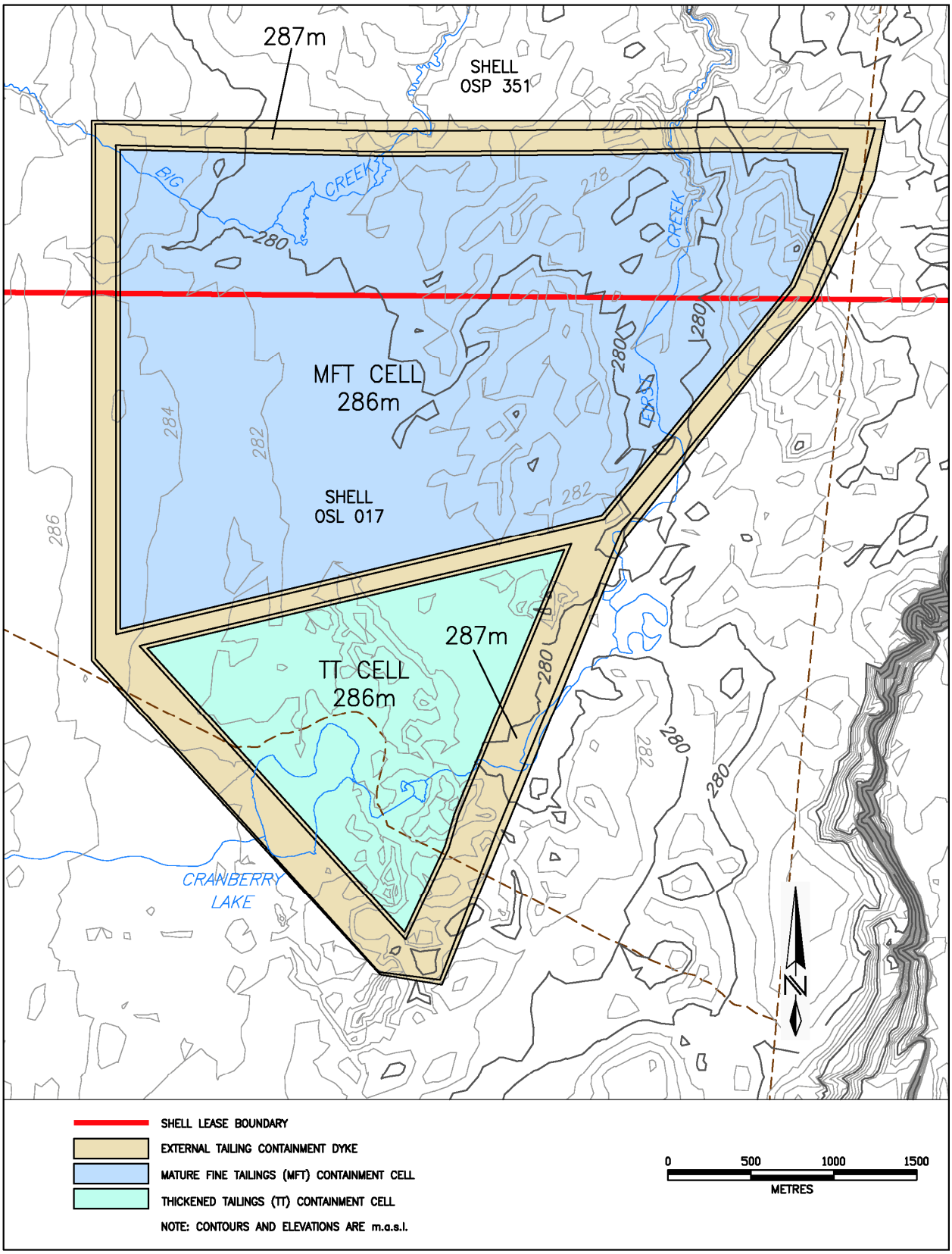


Figure 7-5: External Tailings Disposal Area – Year-End 2018

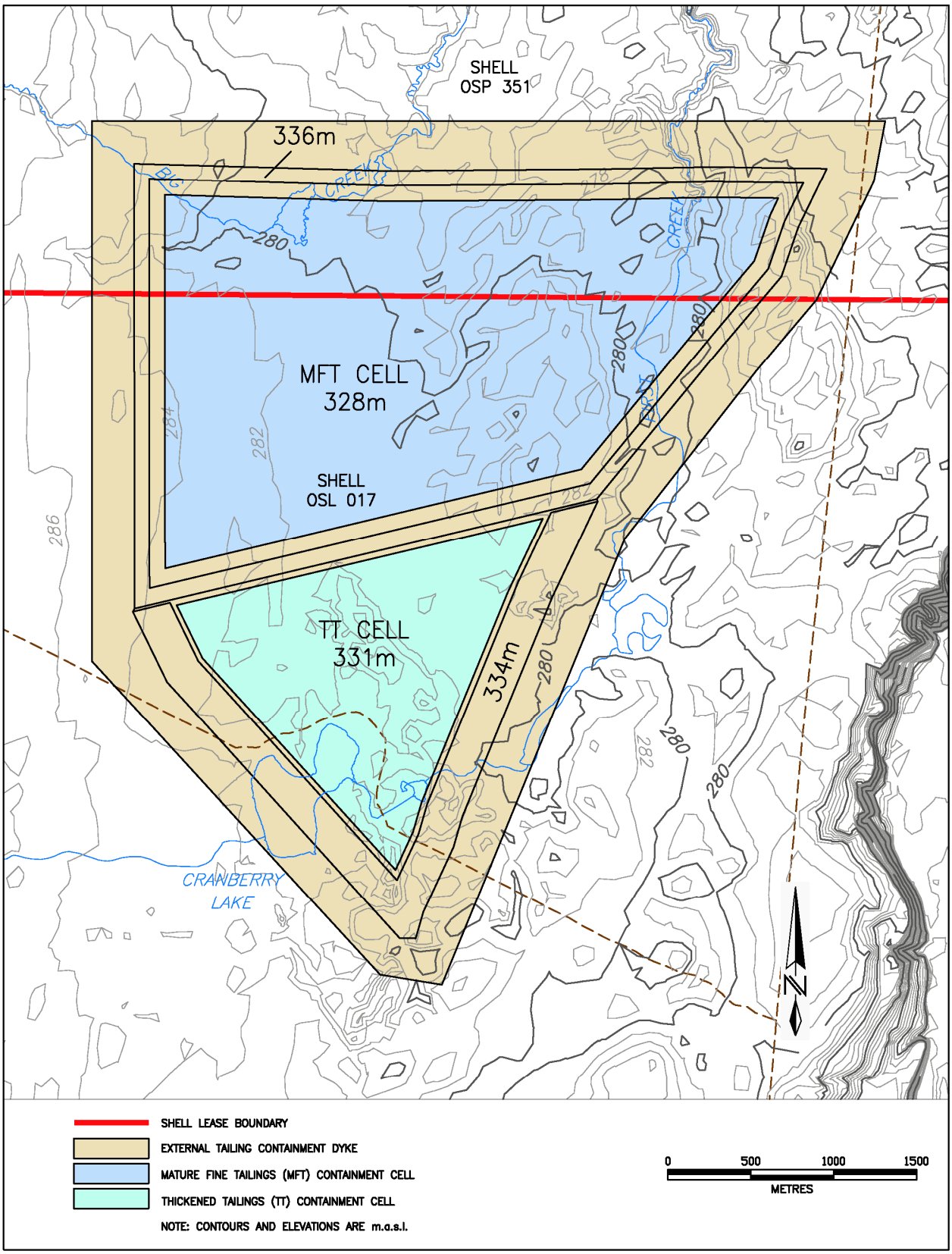


Figure 7-6: External Tailings Disposal Area – Year-End 2028

2033 to 2039

Cell 2 will be established in 2033, and tailings deposition will begin in 2034, continuing until 2038. Cell 2 will have a storage capacity of about 204 Mm^3. Tailings will be deposited in Cell 4 from 2037 to 2039. Cell 4 will provide 109 Mm^3 of tailings storage. A small volume of TT and TSRU will be deposited in a low area in the pit floor in the end-pit lake during CST capping of Cell 4 in 2039.

Fluid Cell 1 will continue to receive TFT transfers from the active tailings cell, and will be filled to the design capacity of 100 Mm^3 in 2037. Fluid Cell 2 will be active in 2037 to receive TFT transfers from 2037 to the end of operations in 2039.

The in-pit disposal sequence is shown in:

- Figure 7-7, showing year-end 2029
- Figure 7-8, showing year-end 2034
- Figure 7-9, showing year-end 2039

Table 7-2 outlines the overall sequence for these requirements.

Table 7-2: Tailings Activity Sequence

Location	Timeline	Activity
External tailings disposal area	2017 to 2018	Construct starter dykes with overburden. Conventional upstream dykes will be constructed for the north MFT pond and cross dyke, and downstream dykes for the south TT area.
	2018 to 2028	The north MFT cell upstream dykes and south TT cell centreline dykes will be constructed with CST and supplemented with overburden when there is a cell sand deficiency. The north cell will be filled with CST and TSRU and the basin will be used for TFT storage. The south cell is filled with TT.
	2029 to 2039	ETDA will be inactive.
	2040 to 2045	Transfer MFT from the main tailings area to the end-pit lake.
	2040 to 2045	Construct an overburden disposal area against the west side of the north cell. Closure drainage will be established over the OBDA to the pre-disturbance terrain.
In-pit cells	2018 to 2027	Construct dykes to contain Cell 1a and fluid Cell 1. An overtopping dyke will contain tailings to 255 m in Cell 1a.
	2027 to 2028	Transfer 12 Mm^3 TFT from ETDA to fluid Cell 1.
	2028 to 2037	Fluid Cell 1 will be used for TFT transfers from active tailings cells. The MFT barge and reclaim water barge will be in operation.
	2029 to 2035	Tailings deposition in Cell 1.
	2028 to 2036	Complete dyke construction for all in-pit cell containment.
	2037 to 2039	Fluid Cell 2 will be used for TFT transfers from active tailings cells.
	2034 to 2038	Tailings deposition in Cell 2.
	2037 to 2039	Tailings deposition in Cell 4.
	2039	A small amount of TT and TSRU will be deposited in the end-pit lake during CST capping of Cell 4.

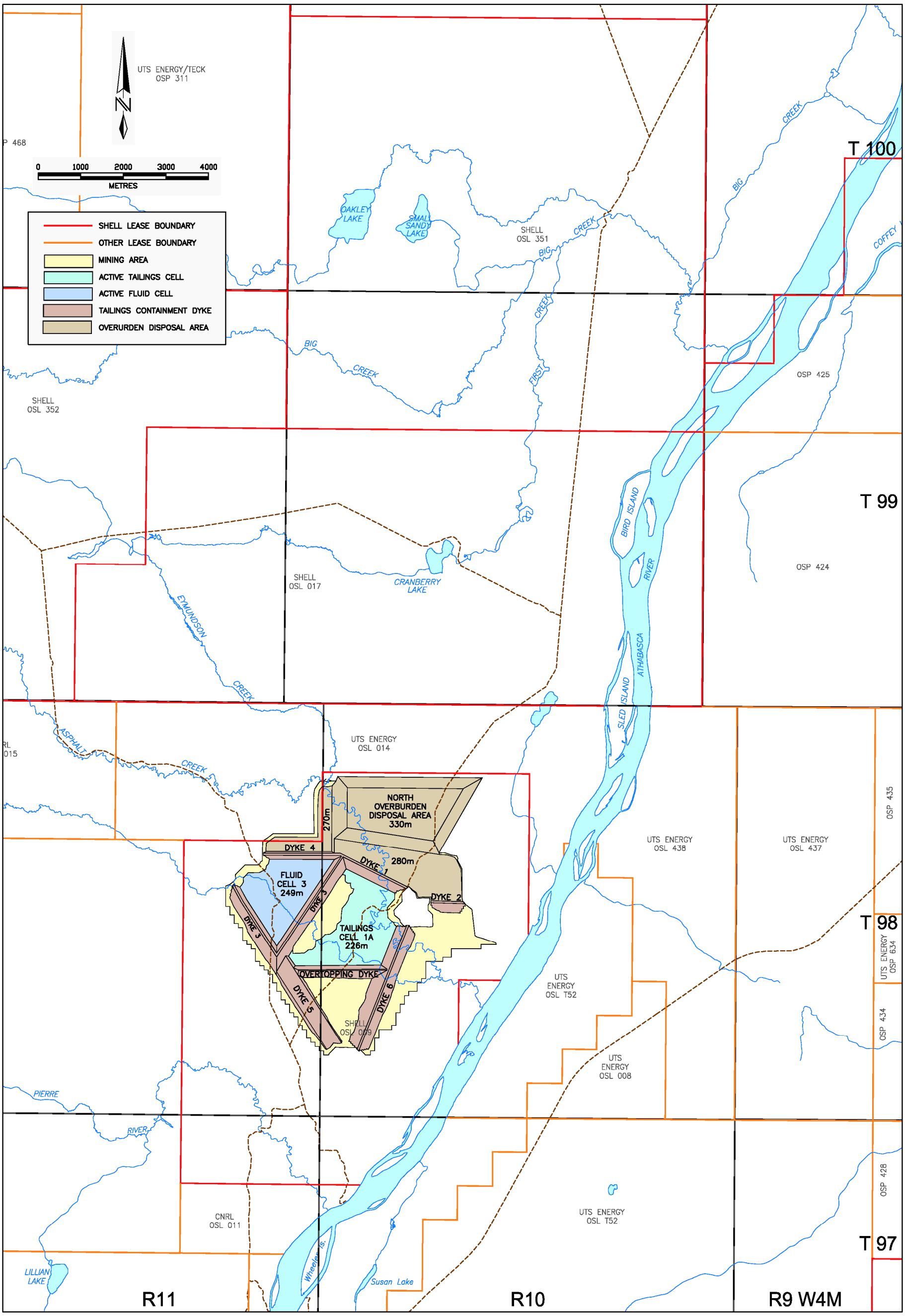


Figure 7-7: In-Pit Disposal – Year-End 2029

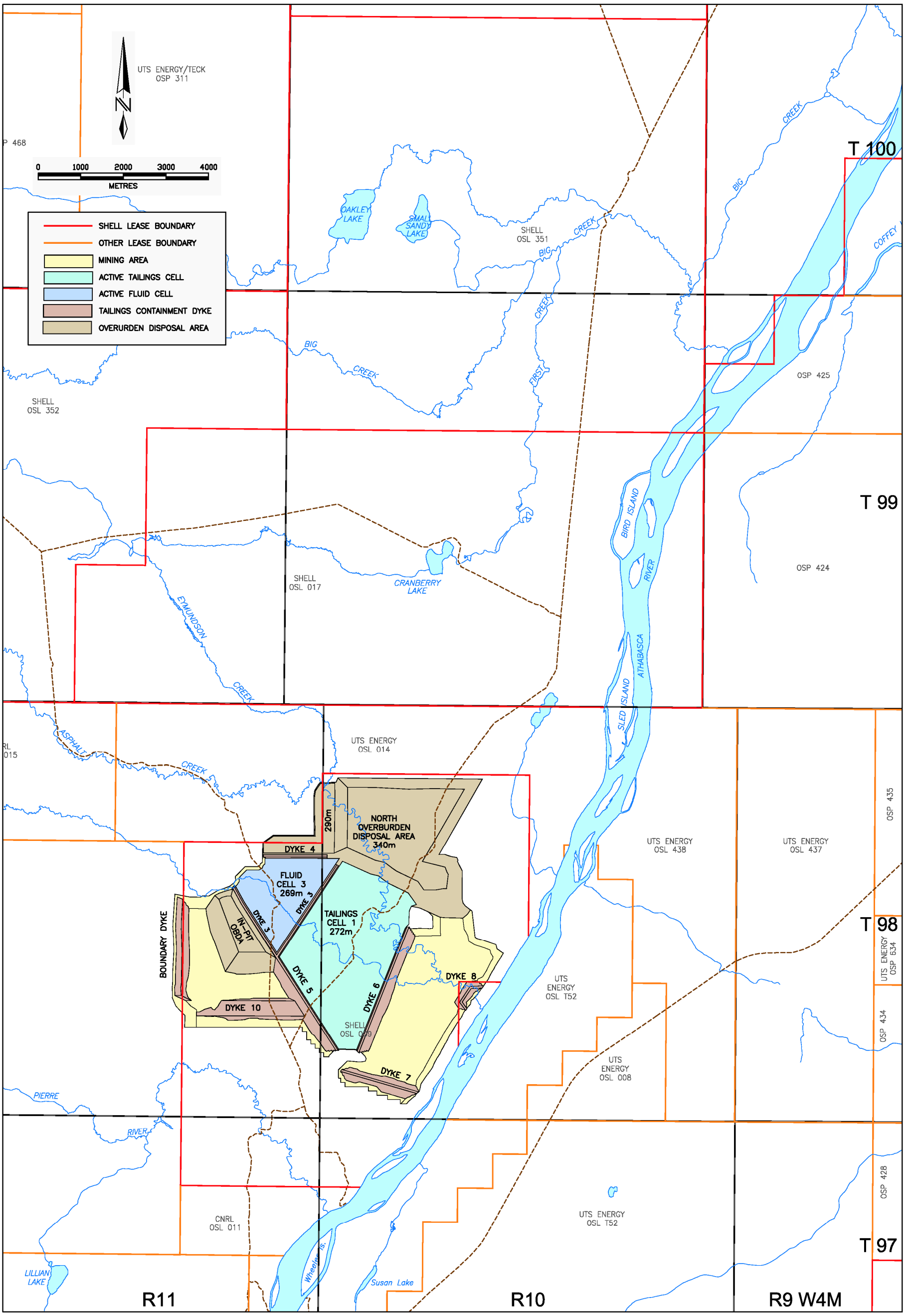


Figure 7-8: In-Pit Disposal – Year-End 2034

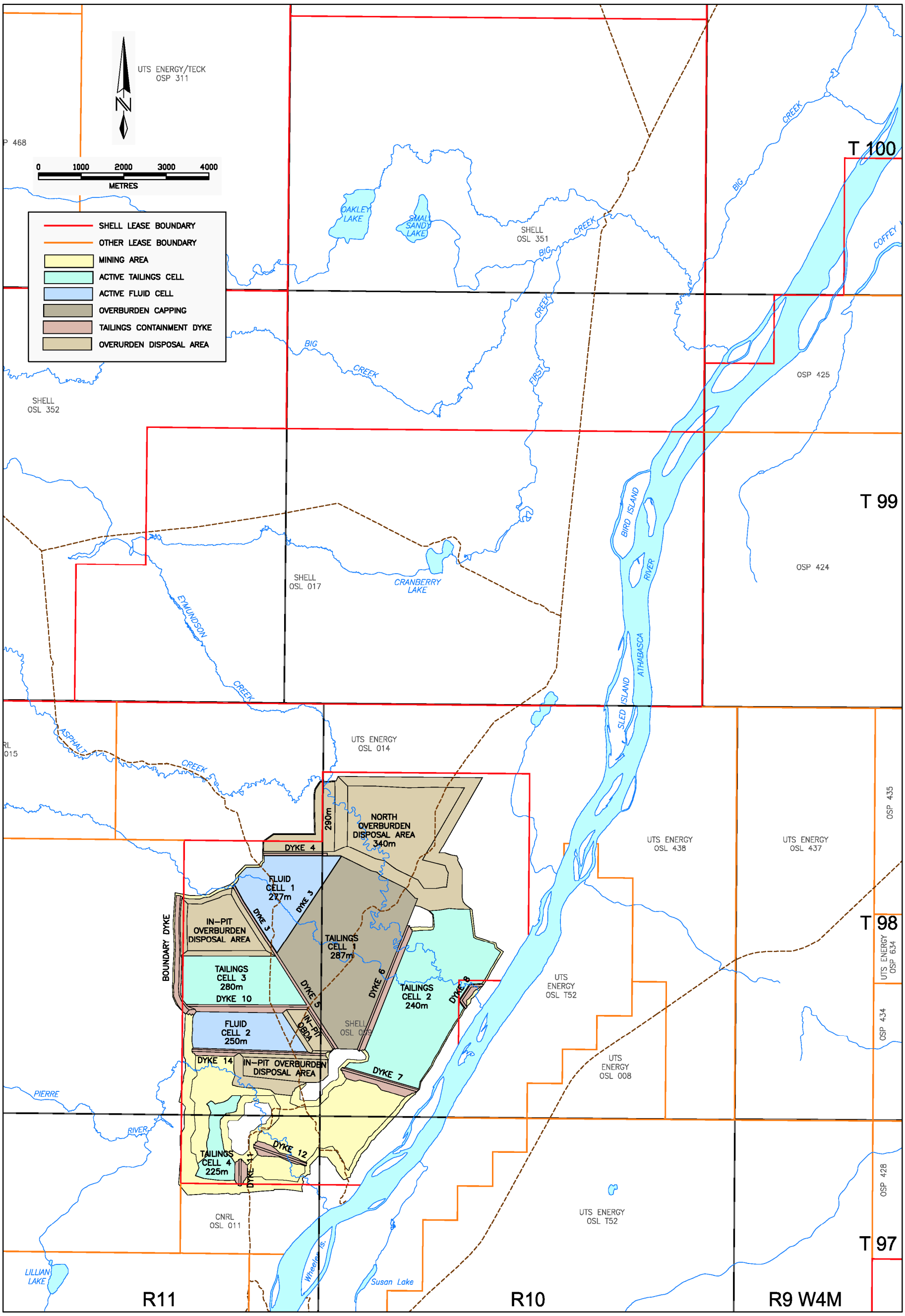


Figure 7-9: In-Pit Disposal – Year-End 2039

DESIGN CRITERIA

Table 7-3 summarizes the dyke and toe berm geometry required to meet ETDA conceptual design and safety targets to a design elevation of 336 m. Lengths of dyke modifications (slope flattening and toe berms) were estimated, and will be revised based on additional geological data and stability analyses during further front-end engineering and design processes.

The ETDA geometry is shown in:

- Figure 7-10, showing the cross-sections through the TT perimeter dyke and the cross dyke
- Figure 7-11, showing the design cross-sections through the upstream dykes

Beach-Below Water Tailings

Long above-water beaches will be maintained in the main pond to mitigate potential problems with liquefaction with beach-below water tailings.

Thickened Tailings Beach

The tailings plan maintains a TT beach within about 5 m of the dyke crest at all times. The pond management plan will direct the water away from the dyke so that a beach is maintained adjacent to the centre-line dyke at all times.

GEOLOGICAL CONSIDERATIONS

Muskeg

Muskeg averaging 2 m thick is found within the footprint.

Sands and Gravels

Sands with minor gravel lenses and shallow channels ranging in thickness from 30 to 50 m underlie the muskeg.

Table 7-3: External Tailings Disposal Area Retention Structure Design Criteria

Component	Design Considerations	Off-Setting Factors
Retention Structure		
Offsets	1,600 m west from the Athabasca River.	
Overall geometry	Downstream slope 5:1. Crest width 30 m. Maximum dyke height 60 m.	Intermediate berms required for monitoring access.
Construction method	Tailings area dykes use upstream method.	
Overburden starter dyke	Overburden required to a width two-thirds of the dyke height for upstream sections, and full width on the centreline and downstream sections.	
Compacted cell	Conventional cell construction and compaction. Fines content (less than 44 μm) of cell sand assumed to be 4%.	
Main Tailings Area		
Size	Dictated by sand storage volume.	Preferred below-water deposition to enhance fines capture in beaches.
Beach	Beaches based on two beach-above water (BAW) to 7.5% beach-below water (BBW) slopes. Beaches based on having 9.3% fines (less than 44 μm).	
Water inventory	No recycled water for about two years until a 3-m-deep clear water zone is formed.	Might require one year or less with caustic-free tailings.
Fine tailings consolidation	Design assumes 18-month settling time for TFT to consolidate to MFT.	
TT Area		
Size	Dictated by TT storage volumes.	
Thickened tailings deposition	Spigotted from perimeter dyke at an assumed 0.5% slope.	
Water cap	Operated subaerial in summer.	No water cap.
Seepage Collection		
Interior drainage	Seepage from construction water and infiltration collected internally by collector pipes and filter cloth drains. Seepage estimated around 23 m^3/cd per metre of dyke length when the pond is at the full design height.	All process water returned to the main tailings area.
Toe ditch	Entire ditch around the circumference of the disposal area. Collects seepage water from drain outtakes and surface runoff from the disposal area.	Water will collect in sumps from the ditch and will be pumped back to the main tailings area.
Service road	Located beyond toe ditch.	

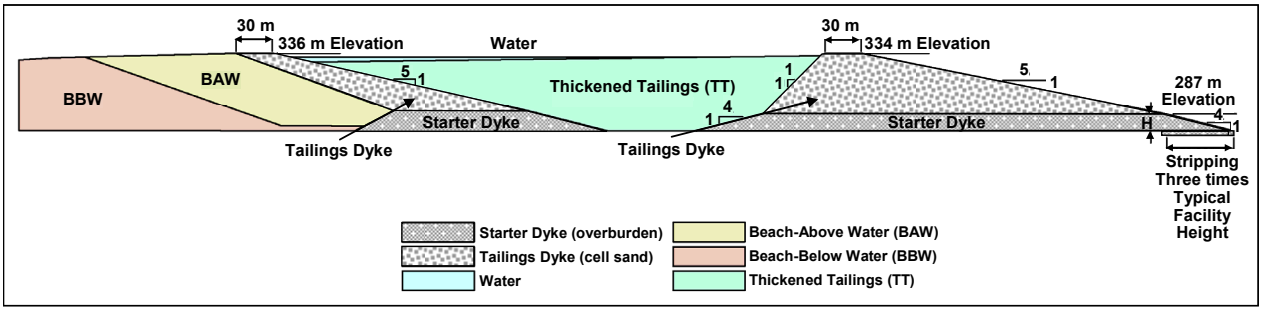


Figure 7-10: Cross-Sections through TT Perimeter Dyke and Cross Dyke

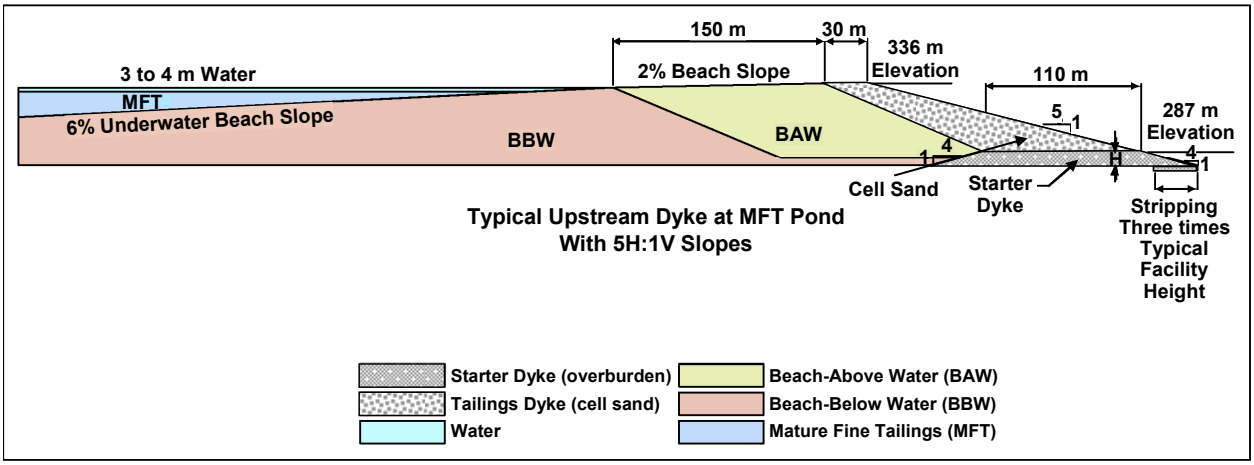


Figure 7-11: Design Cross-Sections through Upstream Dykes

CONSTRUCTION METHOD

Starter Dyke and Perimeter Facilities

In 2017 and 2018, the starter dyke will be completed with overburden from the pre-stripped mine area and crusher pocket excavation. All starter dykes for the ETDA will be constructed to 287 m with 5:1 slopes. The starter dyke for the TT pond will be constructed with a crest width of 250 m and a perimeter length of 5.5 km. The MFT pond starter dyke will be constructed with a crest width of 140 m and a perimeter length of 10.6 km. The starter dyke will be constructed for the cross dyke to segment the ETDA into the MFT, and TT ponds will have a crest width of 100 m and a length of 3 km.

A drainage ditch will be excavated next to the outside toe of the total dyke circumference. A road will be located next to the ditch and along the full length of the dyke.

Tailings Sand Dyke Construction

Construction of the sand dykes on top of the starter dyke will begin in 2018. Figure 7-10 shows typical cross-sections of the upstream constructed dykes and typical cross-sections through the thickened tailings perimeter dyke and cross dyke.

The design and construction methods proposed for the sand dykes are similar to those used in the approved South ETDA at the Muskeg River Mine. The sand dykes will be constructed with minimum side slopes of 4:1, depending upon the final evaluation of the existing subsoil conditions at the site.

The dyke section will be designed as a hydraulic fill structure. To provide a stable section under all expected conditions, the structural portion of the dyke will be compacted to a minimum 70% relative density. To control the phreatic surface and prevent seepage water from exiting on the downstream slope, seepage control will be provided by internal drains.

The tailings stream will be discharged into the main cell. The coarse sand will settle out by gravity and the fines fraction in suspension will flow out through an overflow weir into the main tailings area.

Dyke-building experience indicates that the specified minimum densities of over 70% can be achieved by wide-track bulldozers operating in the cells during hydraulic placement.

Cell construction cannot be sustained when visibility is poor. Therefore, in winter, all of the coarse tailings will be discharged directly into the main tailings area upstream of the compacted dyke section. A beach of uncompacted sand will be formed, which will abut the compacted dyke section and extend into the main tailings area on relatively flat slopes of 1:20. The beach runoff containing fines will flow to the low side or end of the tailings disposal area being developed at any particular time.

External Tailings Disposal Area Size Considerations

Clarification Area

The clarification area will be large enough to result in sufficient solids settling to clarify the extraction recycle water.

Clear Water Zone

The clear water zone must be at least 3 m deep to:

- ensure that wave action and current effects do not mix up settled sediments at the mudline
- enable the recycle water barge to operate properly, thereby minimizing the resuspension of settled solids

Thin Fine Tailings to Mature Fine Tailings Transition

The transition from TFT to MFT occurs about 12 m below the bottom of the clear water zone.

Beach Angles

An important criterion is the angle used for upstream beach slopes formed by the segregating sand. For planning purposes, the slope angle was designed at 2% for beach-above water and 7.5% for beach-below water.

Water Recycling

Water recycle is an essential component of a tailings operation that uses hydraulic transport. However, to avoid affecting the extraction process, water cannot be recycled to the extraction plant until it is adequately free of solids. Water from the tailings area is not expected to be recycled until MFT water clears up, to ensure that the water is of the required quality. If faster settling behaviour of the MFT is realized, this recycle can occur sooner.

DESIGN CRITERIA

The major design criteria for in-pit dykes, NST settlement and reclamation for the in-pit disposal operations are summarized in Table 7-4. Figure 7-12 shows a typical cross-section of an in-pit dyke with NST fill.

IN-PIT DYKES

The pit will be divided into five separate cells. Cells 1, 2 and 4 will be filled with NST, TT, TSRU and capped with CST. Fluid Cell 1 and 2 will act as clarification cells for the TFT transferred from active tailings cells, and will be water-capped.

All in-pit dykes will be constructed of interburden and overburden. Construction of in-pit dykes will begin in 2023. The current tailings plan assumes that NST disposal will start in-pit in 2029, and TFT disposal will begin in 2028. By the end of 2027, in-pit Dykes 1, 2, 3 and 4 will be complete. The overtopping dyke for Cell 1 will be constructed to full height by 2029. By the end of 2034, the in-pit dykes for Cell 2 will be constructed to full height. The in-pit dyke for Cell 4 will be constructed to full height in 2036. The dykes for fluid Cell 2 will be constructed before TFT transfers start in 2037.

The design basis for in-pit dykes assumes the foundation comprises the Devonian Waterways limestone unit. Experience at the Muskeg River Mine indicates that the Devonian unit is a competent foundation, and similar strength parameters were used. Lower McMurray clays (LM2) form the base of feed in localized regions of the Pierre River pit. The LM2 has been removed from the footprint of all in-pit dykes in the design to provide optimum foundation conditions.

NST PLACEMENT

For planning purposes, the NST plant operations are assumed to discharge into each cell directionally from the in-pit dyke crests toward the mine pit walls at the far end of each cell, so that each dyke will be buttressed by an NST beach. The fluid cell level at the far end of each of the deposits will be kept low by a water recycle barge and decant operation. Final infilling requirements and the schedule for the pits are determined by:

- the overall mine plan
- dyke layouts

NST PLACEMENT (cont'd)

- mass balance
- NST behaviour

Table 7-4: In-Pit Disposal Design Criteria

Component	Design Considerations	Off-Setting Factors
In-Pit Dykes		
Geometry	In-pit dyke slopes 3:1 upstream and 4:1 downstream, using good quality fill.	Geological interpretations indicate that pit floor conditions are favourable with no Continental Pond Mud facies.
Construction method – unzoned fill	The design incorporates preferential placement of more pervious material in the downstream section. The design does not allow for water ponding against any dykes that are required to support unzoned fill dams.	The NST disposal plan must accommodate some subaerial beaches between the NST pond and the dyke. Otherwise, dykes must be designed as water retention structures, requiring zoned fills and filters. The final design might evolve to a steeper upstream slope partially supported by NST, and flatter downstream slope to accommodate overburden types.
NST Settlement		
NST cell sand capping	Sand capping will occur at the end of each cell life to ensure that 10 m of sand caps each cell before overburden placement.	
Infilling consolidation	Design predictions are based on a sand-to-fines ratio of 5:1 and predicted NST geotechnical parameters.	The key variable is the clay content of MFT used for NST, based on current orebody data.
Post-infilling settlement	Estimated at 3.5 m in five years for a sand-to-fines ratio of 5:1.	Faster settlement is expected with caustic-free tailings.
Reclamation		
Post-NST deposition infilling	The mine plan requires additional material placed over NST to accommodate overall drainage requirements.	Sources are rejects and overburden. Tailings sand is not available for NST deposit infilling.
Infilling stability	A surface layer that is trafficable in winter over frost crust and with immediate stable capping, i.e., no inversion of capping.	Might need drainage ditches down to NST to allow lateral drainage of NST consolidation water.
Fines consolidation in end-pit lake	Thin fine tails will consolidate to at least 30% solids content over several years.	Caustic-free tailings are expected to consolidate faster and to a higher solids content.

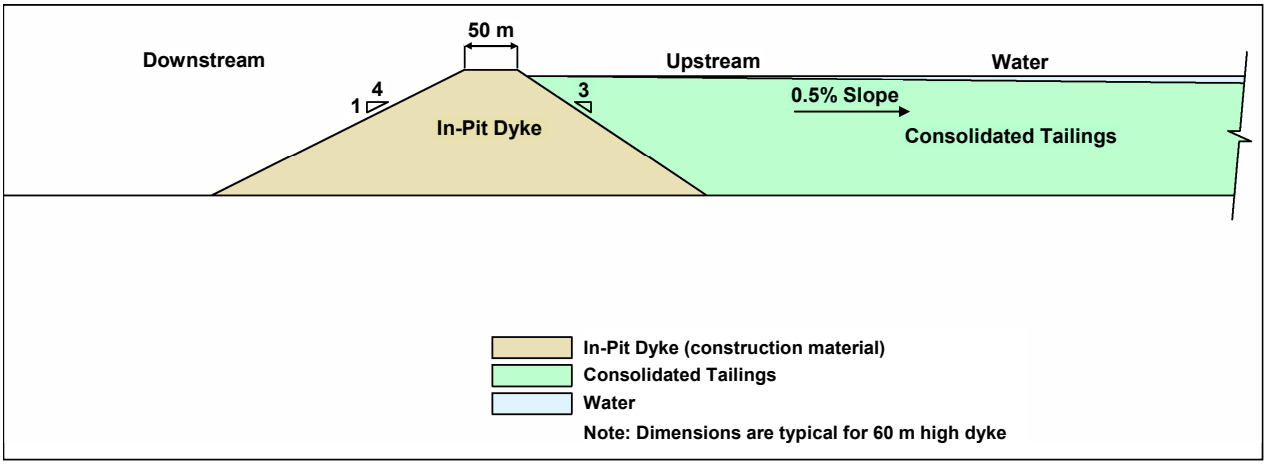


Figure 7-12: Typical In-Pit Tailings Dyke Cross-Section

These factors are highly interactive and the NST infilling plan is influenced by the following:

- The NST surface post-infilling settlement rate depends on the rate of infilling and the sand-to-fines ratio.
- The in-pit topographical surface required for closure drainage is at a higher elevation than the infilling levels reached by NST deposition, even assuming that there is no NST settlement.
- A 10 m CST cap will be placed on the NST to generate sufficient strength on the ground surface to place an overburden cap.
- The progressive reclamation of in-pit segments will be undertaken during the operational mine life.
- The time required to complete the reclamation plan will be minimized.

The implications of these factors are that:

- additional fill must be placed over NST surfaces to account for both settlement and elevation differences between mine plan constraints and topographical drainage requirements. This fill will be placed both hydraulically and by mobile equipment while the NST is still not fully consolidated.
- additional fill requirements are planned from other indirect sources:
  - tailings sands produced when the NST plant is not operational
  - overburden hauled from working mine faces

Placement of additional fill over the NST is governed by the foundation support offered by NST and the requirements to provide the release of consolidation

NST PLACEMENT (cont'd)

water. Because fill might be placed before all settlement is realized, fill will likely be placed higher than the final grade requirements and be allowed to settle.

CELL DEPOSITION DESIGN

Each in-pit cell will be filled by discharging NST and TSRU concurrently into the cell. TSRU deposition will be restricted to one part of the cell to reduce any effect TSRU might have on the NST stream. NST will be discharged from three lines and three or more spigots, which will be moved around the pond for efficient filling.

The final 10 m of cell will be filled with coarse sand tailings to produce a consolidated cap that supports the overburden placement and promotes drainage of the underlying tailings deposit. During placement of the coarse sand cap, TT will be produced. The TT, along with the TSRU stream, will be deposited directly into the next available cell.

During tailings deposition, TFT will accumulate in the active pond, and will be transferred out of the cell before sand and overburden capping. Some TFT will be pumped back to the tailings plant and recombined in the NST stream, but most MFT will require separate storage. Fluid Cells 1 and 2 will be designated for permanent MFT storage during tailings operations.

Water volume in the active cell will be maintained to achieve a 3 m water depth for subaqueous TSRU deposition. When sand capping, water and TFT will be transferred to the clarification cells.

Each consecutive in-pit cell will be filled similarly. The tailings deposition strategy for clarification cells will be to minimize the volume of solid tailings placed in the cell to maximize the volume of TFT storage capacity. Fluid Cell 1 will be used as the first clarification cell.

The final cell will be designated as an end-pit lake, so the temporary storage available in that cell will be greater than the allowable tailings storage volume in the cell, because of the water volume stored at closure. This excess available volume will be used to increase the temporary TFT storage volume during operations.

Table 7-5 lists the individual cell volumes.

CELL CAPPING

The mine plan proposes placing mine overburden over in-pit NST tailings cells two years after NST deposition is completed. Of the five in-pit cells, three will be capped with overburden and two will be end-pit lakes. Overburden caps are required over the in-pit tailings cells to create a terrestrial landform that will conform to the mine closure plan.

Table 7-5: In-Pit Cell Storage Volumes

Cell No.	Dyke Containment	Tailings Stored	Tailings Elevation (m)	Cell Volume (Mm^3)
1	1, 2, 3, 5, 6 and overtopping dyke	NST, TT, TSRU and CST	280	414
2	2, 6, 7 and 8	NST, TT, TSRU and CST	240	204
Fluid Cell 1	3 and 4	TFT	280	109
4	3, 5, 10 and CNRL boundary dyke	NST, TT, TSRU and CST	280	110
Fluid Cell 2	10 and 14	TFT	250	40
5 (End-pit lake)	7, 11, 12 and 14	TT and TSRU	225	10
			Total Storage	877

Capping Sequence

Capping and overburden waste materials will be placed in stages, as follows:

- Stage 1 – Place a coarse tailings cap over the NST. The cap will be a nominal 10 m thick, and grading will be at about 1% to a low point for drainage.
- Stage 2 – Install subsoil drains. The drainage grid and instrumentation within the surface of the sand tailings will drain the cell during overburden placement and subsequent consolidation, and monitor pore water pressure response in the upper tailings. Cell drainage will continue for a minimum of two years before Stage 3.
- Stage 3 – After drainage is complete, place the first layer of overburden, with a nominal thickness of 3 m, during the next year.
- Stage 4 – Place the subsequent layers of overburden. The number of layers will be determined by the closure landscape elevation required and by monitoring and assessing consolidation, shear strength and pore water pressures within the sand layer and the NST deposit.

END-PIT LAKE

The mine and tailings plan results in a void that will become the end-pit lake. Fluid Cell 2 containment is designed to breach Dyke 14 below the end-pit lake water elevation during decommissioning to contain the MFT within the cell, and create a common water cap with the end-pit lake.

The 111 Mm^3 of MFT and water cap contained in the ETDA will also be transferred to the end-pit lake during decommissioning. This operation will take several years to accomplish, as dewatering will be restricted by:

- rapid drawdown restraints of the main tailings area's interior beach slopes
- the rate that will enable natural biological decay of any residual toxicity associated with the water

END-PIT LAKE (cont'd)

The fine tailings will achieve most of its settlement within a few years after transfer is complete, and will slowly consolidate thereafter.

Dykes 11 and 12 will be constructed to create a clean water cell within the end-pit lake that is free of any tailings. The end-pit lake will discharge water from the clean water cell through a constructed closure channel into the Athabasca River.

ANNUAL MATERIAL BALANCE

The annual material balance over the life of tailings placement (see Table 7-6) shows the flows each year to the external and in-pit tailings disposal areas.

Table 7-6: Annual Tailings Material Balance

Year	NST (Mm^3)	TSRU Tailings (Mm^3)	Coarse Tailings (Mm^3)	Thickened Tailings (Mm^3)	TFT (Mm^3)	Total Tailings (Mm^3)
2018	0	0	5	1	1	8
2019	0	1	12	3	4	20
2020	0	2	25	7	8	41
2021	0	2	30	8	9	49
2022	0	2	37	10	12	61
2023	0	3	49	14	16	82
2024	0	3	49	14	16	82
2025	0	3	48	14	15	79
2026	0	3	50	14	16	84
2027	0	3	50	14	4	71
2028	0	2	35	10	16	64
2029	57	3	0	0	9	70
2030	59	3	0	0	9	72
2031	59	3	0	0	10	72
2032	54	3	0	0	9	66
2033	62	4	0	0	10	76
2034	29	3	25	7	12	76
2035	7	4	52	15	17	94
2036	70	4	0	0	12	86
2037	22	4	38	11	15	90
2038	25	4	34	10	14	87
2039	28	3	27	8	13	78
Total	**474**	**64**	**565**	**160**	**244**	**1,507**

ANNUAL MATERIAL BALANCE (cont'd)

The ETDA will be used exclusively until 2028, then for two years as a transition for NST in-pit placement. Removing the accumulated MFT from the main tailings area will begin in 2042, and the space created will be filled with coarse sand during the last year of plant operation. External volumes of tailings are shown in Table 7-7.

Table 7-7: Cumulative External Tailings Volumes

Year	TT Pond				CST Pond			
	TT (Mm^3)	Sand (Mm^3)	TFT (Mm^3)	CL Dykes* (Mm^3)	Beach (Mm^3)	TSRU (Mm^3)	TFT (Mm^3)	US Dyke* (Mm^3)
2018	1	1	0	7	3	0	1	13
2019	5	1	0	10	13	1	5	18
2020	12	1	0	16	31	3	13	27
2021	20	2	0	19	52	5	22	34
2022	31	3	0	25	78	7	34	44
2023	45	6	0	32	111	10	50	52
2024	59	10	0	37	143	14	65	60
2025	72	12	0	42	176	17	80	68
2026	86	15	0	45	213	20	96	76
2027	100	16	0	47	255	24	100	80
2028	110	29	0	48	274	26	111	83
Note *: Dyke volumes include scheduled overburden quantities.								

In-pit tailings placement will begin with Cell 1 with NST in 2029 (see Table 7-8). The NST process will produce a non-segregating mix about 85% of the time. A small amount of TFT will be produced during NST deposition. Both segregated sand and TFT will be produced during the periods of non-NST operation.

Table 7-8: Cumulative Volumes for In-Pit Cells 1 to 5

Year	NST, CST, TT and TSRU Tailings				TFT	
	Cell 1 (Mm^3)	Cell 2 (Mm^3)	Cell 4 (Mm^3)	Cell 5 (Mm^3)	Fluid Cell 1 (Mm^3)	Fluid Cell 2 (Mm^3)
2027	0	0	0	0	9	0
2028	0	0	0	0	12	0
2029	61	0	0	0	21	0
2030	123	0	0	0	31	0
2031	185	0	0	0	40	0
2032	243	0	0	0	49	0
2033	308	0	0	0	59	0
2034	362	10	0	0	71	0
2035	414	36	0	0	87	0
2036	414	110	0	0	99	0
2037	414	170	14	0	100	14
2038	414	204	53	0	100	28
2039	414	204	109	9	100	40

TAILINGS PUMPING AND PIPELINES

Tailings will be pumped by centrifugal pumps located at the extraction plant. Because of the distance and elevation change, the number of booster pumps required will depend on final layouts and overall system hydraulics.

NST pipeline operations will be designed for a solids content of 67 wt%. Allowable line solids content for pumping, together with the required solids and fines contents for NST production, govern the operation of the NST facility. Two operating NST pipelines will be provided, with one spare line to accommodate line flushes and relocations.

During sand capping, the two NST pipelines will be switched to coarse sand and will operate on a pipeline solids content of 56.6 wt%. The spare line will be used to transport the TT stream at a pipeline solids content of 46 wt%. TSRU tailings will be pumped in two dedicated pipelines to the operating in-pit cells and discharged under a 3 m water cap.

MFT HARVEST SYSTEM

An MFT harvest barge will be used to remove MFT from fluid Cell 1 and return it to the NST pump boxes at the plant site, where the MFT will be used as an addition to maximize fines capture. The barge will be configured to recover MFT from below the mudline in the clarification pond. The mudline is expected to be about 20 m below the pond surface. Over the project life, an estimated 16 Mm^3 of MFT will be recovered from the clarification cells and recombined with the NST stream.

WATER RECYCLE SYSTEMS

A recycle water barge with pipeline will be used to return water from the clarification cell to the plant. Initially, the barge will be moored at the northeast corner of fluid Cell 1, and access down the pit wall will be required to locate the barge at the bottom of the cell. The pipeline access will be maintained on top of in-pit overburden Dykes 1 and 4.

TFT TRANSFER SYSTEMS

A TFT transfer barge with pipeline will continuously remove the TFT and water from the active NST cells and transport it to the clarification cell. The first TFT barge will be located in Cell 1 and the pipeline will be placed along the top of Dyke 1 to discharge into the northeast corner of fluid Cell 1. A second TFT transfer barge will be added for Cell 2 to provide operational flexibility during relocations between cells.

The two barges will be leapfrogged between NST Cells 2, 4 and 5 following the NST placement schedule.

SEEPAGE MANAGEMENT

Seepage will occur from the sand tailings dykes. The sources of this seepage are:

- water from the clear water zone of the main tailings area
- fine tailings consolidation water
- water from the hydraulic placement of sand tailings

This seepage will be collected by filter drains constructed at the downstream slope, then conveyed to the ditch excavated parallel to the downstream toe of the dam. From the ditch, the water will be pumped back into the main tailings area. The filter drains will be required to contain the phreatic surface within the sand embankment, thereby meeting the stability requirements.

The shallow perimeter ditch that collects water from the filter drains will also intercept seepage flows in the foundation soils. This ditch will have much of its base excavated into till, thereby intercepting flows along the interface between the surficial soils and the impermeable till layer. The water level in the ditch will be maintained by pumping the inflow back into the main tailings area.

The drainage ditches will be designed to intercept the maximum seepage from the tailings dykes. These ditches will be deepened to the extent required. A system of monitoring wells will be installed to determine the seepage water quality and the hydraulic gradient toward the receiving waterbody.

RECLAMATION DURING OPERATIONS

External Tailings Disposal Area Exterior Slope Reclamation

The ETDA slopes will be covered with a prescribed thickness of reclamation material stockpile (RMS) material following completion of dyke construction activity. Reclamation of the ETDAs outside dyke slope will begin in 2030.

RECLAMATION AT CLOSURE

Tailings Cell Reclamation

Reclamation of in-pit cells will follow CST and overburden capping operations. Final contouring of the overburden capping to establish the closure drainage plan will be completed by hauling overburden directly from the active mine face, or removing rehandled overburden from in-pit dumps during decommissioning. Reclamation material will be hauled directly from existing mining areas or rehandled from the reclamation material stockpile.

Cell 1 will be the first to be reclaimed in 2042, and Cells 2 and 4, which have been capped with overburden, will be reclaimed during decommissioning.

External Tailings Disposal Area Interior Reclamation

MFT and water left in inventory in the main tailings disposal area will be transferred to the end-pit lake, when it is available, and stored under a water cap. Transferring TFT will result in a bowl-shaped depression within the dyke structure that will be drained by excavating a drainage channel through the perimeter dyke to the west and over the OBDA constructed on the dyke slope during decommissioning. Figure 7-13 shows the final reclamation of the ETDA.

The west TT area will be refilled during the last years of operations to account for the settlement that will have occurred. A drainage channel will be excavated through the cross dyke to provide drainage from the TT pond through the drainage channel constructed through the MFT pond.

The drainage channel will drain water collected in the ETDA through decommissioning and closure water treatment ponds into the Athabasca River.

Fluid Cell Reclamation

A water cap will be maintained on fluid Cell 1 at closure to establish a pit lake. Local drainage will be directed into the pit lake, which will be drained south to the end-pit lake by a closure drainage channel.

Fluid Cell 2 will be integrated into the end-pit lake at closure. The south containment (Dyke 14) will be re-graded at closure to about 1 m below the ultimate end-pit lake elevation. The dyke will contain the MFT within the cell, and together both the MFT cell and the end-pit lake will be capped with water.

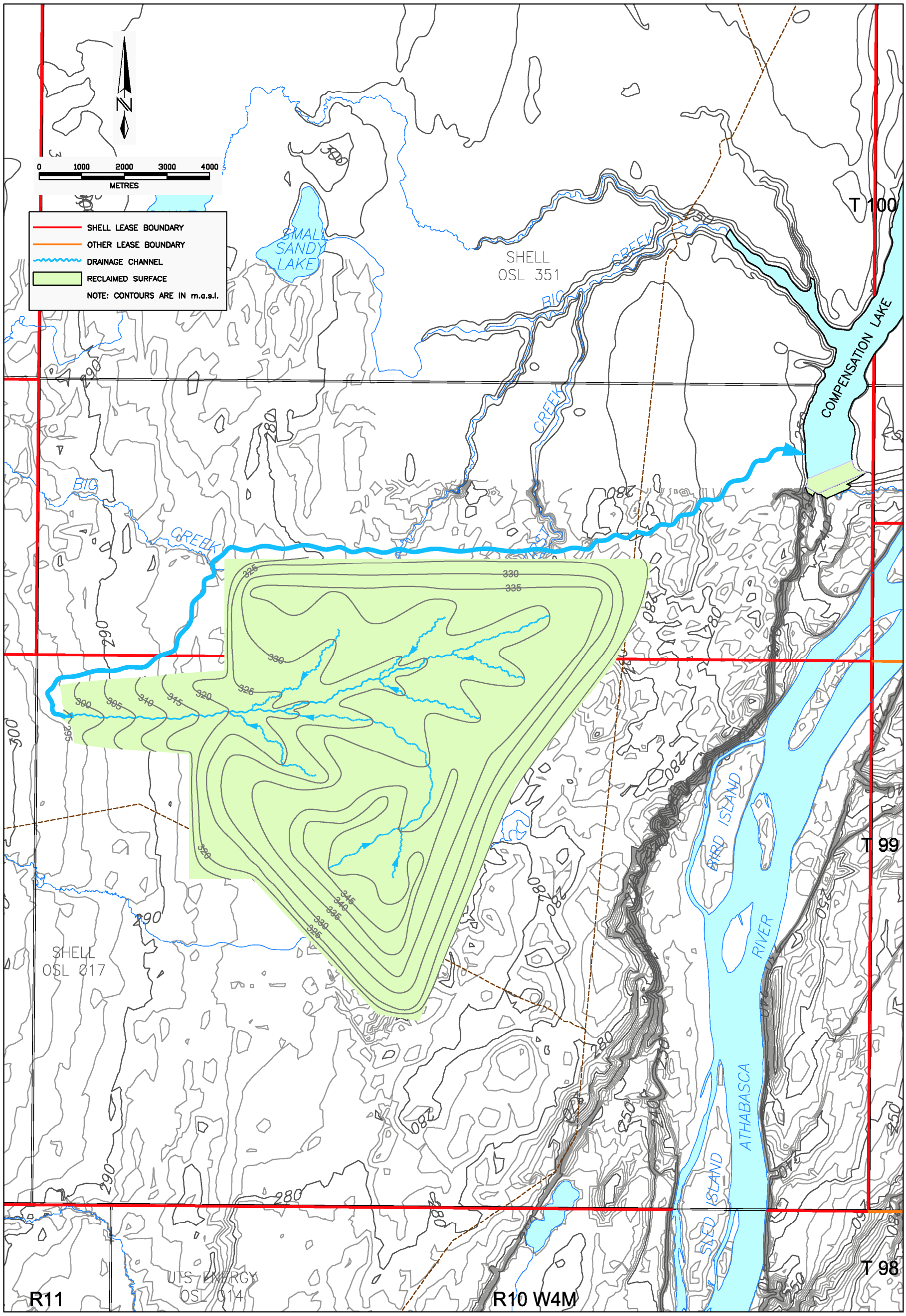


Figure 7-13: Reclaimed External Tailings Disposal Area

SCOPE

The development of tailings technology is generally focused on establishing an economically viable and operationally robust tailings system that produces a competent strength tailings stream with high fines capture that provides a predominately dry landscape for effective reclamation. Initial work includes the construction and operation of a tailings field demonstration plant with a testing program that:

- generates several large volume test deposits of various density, and sand-to-fines ratios to evaluate strength and fines capture characteristics
- evaluates cyclone and thickener capabilities to produce high-density tailings products
- evaluates a variety of tailings transportation, deposition and capping strategies

NST PROCESSING

Objectives

By incorporating more fines into the sand matrix, as is done with NST, less MFT needs to be stored in end-pit lakes.

The premise for producing NST is an on-line process that recombines the coarse and fine tailings streams on the same day as the mineral solids are disaggregated. Currently, the process is based on:

- commingling a coarse mineral solids stream, such as via cyclone densification, and a thickened fine mineral solids stream, such as via flocculant-assisted tailings thickening processes
- adding a coagulant, such as gypsum
- depositing the slurry into mine pits

The objective is to incorporate fine mineral solids into the sandy deposit matrix in a proportion and with sufficient homogeneity that the deposits created can be capped and reclaimed to:

Objectives (cont'd)

- provide predominately terrestrial reclamation scenarios
- manage and mitigate environmental hazards associated with the mineral solids and the water released from the deposits

The objective of creating non-segregating slurry using the NST process is to:

- entrain the fine mineral solids within the skeleton of the coarse (sandy) matrix so that the fine solids do not become re-suspended in the runoff to form thin fine tailings
- generate a deposit that can be reclaimed to primarily terrestrial land uses in a timely and cost-effective manner

ASSESSING EFFICIENCY

A range of potential application scenarios can fit within the objectives of the NST process, each scenario having different fine mineral solids capture efficiency. One of the key outcomes of the 2007 NST demonstration plant, and efforts in subsequent years, will be an improved understanding of the logistical challenges associated with producing and distributing higher density NST slurries relative to lower density NST slurries. In addition, alternative means of incorporating the fine mineral solids into trafficable, reclaimable deposits will be evaluated. The effect of fines capture is obvious and measurable in that the higher the efficiency of fines capture in the tailings deposit, the less TFT that will be produced from the deposition efforts. The effect of deposit variability is less obvious. Generally, areas with higher relative fines content will be slower to consolidate and will present strength or trafficability problems, which will affect the ability to place an overburden cap and delay the reclamation progress.

RESULTS OF PREVIOUS WORK

Previous work done at the Muskeg River Mine has shown that the non-caustic extraction process has advantages, particularly, that fine tailings exhibit faster settling behaviour than traditional caustic tailings. The steps included in the extraction process result in tailings streams that have been subject to size classification. The properties of the coarse tailings stream, consisting of most of the +44 μ size fraction, are typical. This stream will be used for both cell and beach construction, depending on the season and need. The reduced fines in the coarse tailings stream will result in more uniform compaction when constructing cells. The consolidation and permeability parameters for the thickened tailings and TSRU streams are not known from the existing oil sands operations. Research will continue to focus on defining the properties of the thickened tailings and the TSRU tailings streams.

Previous test work has included:

- column work at the Canadian Centre for Mineral and Energy Technology (CANMET) facilities in Devon, Alberta
- measurements on large tank samples at the Muskeg River Mine pilot plant

Shell has also participated in two joint industry partnerships:

- the Canadian Oil Sands Network for Research and Development (CONRAD) Aurora thickener pilot
- the multi-client paste-pumping study at the Saskatchewan Research Council (SRC) facility in Saskatoon

Shell continues to participate in an international research program operated by the Australian Mineral Industry Research Association (AMIRA). This program is directed at improving the understanding of thickener design and operation.

TAILINGS DISPOSAL INITIATIVES

In support of both external and in-pit tailings disposal, further initiatives will address:

- ongoing paste pipeline flow studies at the SRC
- fine tailings rheological studies at the University of Melbourne
- improved thickener technology by AMIRA
- the mechanical thickening of MFT
- TSRU tailings heat recovery

Paste Pipeline Flow Studies

The current basis for non-segregating tailings is preparing clay and water mixtures with enough yield stress to allow the mixtures to remain non-segregating through the addition of calcium forms. Paste pipeline flow programs will be initiated to study these non-segregating tailings. The time-dependent behaviour of these slurries has been a concern when considering how to use pipelines for transportation.

Fine Tailings Rheological Studies

The fine tailings rheological studies are intended to provide a thorough characterization of the rheological properties, both in shear (for pumping and pipeline flow) and compression (for dewatering and behaviour in a pond).

Improved Thickener Technology

The improved thickener technology initiative focuses on obtaining a better understanding of the design and operation of thickeners. The benefits of the studies include modifications to the plant that would result in:

- higher heat recovery via hot water recycled to the process

Improved Thickener Technology (cont'd)

- improved water recovery and less water sent to the tailings pond
- more flexible tailings production with the ability to control solids content to tailor for NST

The work program includes:

- full thickener modelling using computational fluid dynamics (CFD)
- physical modelling and plant measurements
- relating flocculant state to dewatering measurements
- control options, process model and a knowledge-based system

Thin Fine Tailings Mechanical Thickening

The thin fine tailings runoff from the cell and beaching operations will remain in the external tailings disposal area, and over 18 months will reach a fines-to-fines and water ratio of 30% and become mature fine tailings (MFT). This will result in large volumes of MFT requiring storage in the external tailings area. Shell will be studying the feasibility of returning MFT continuously to the plant and thickening it mechanically. This will have beneficial effects on the external tailings area, such as reducing its size. A research program will be conducted to develop the settling characteristics of MFT in a thickener and to look at:

- flocculant dosage
- thickener size
- underflow density

TSRU Tailings Heat Recovery

The TSRU tailings represent a significant heat loss to the Pierre River Mine. Shell will initiate research programs to study approaches to recover heat from the TSRU tailings before disposal.

MUSKEG RIVER MINE FIELD TESTS

Several ongoing test programs are scheduled during the demonstration plant and Muskeg River Mine operations. In addition to the demonstration plant programs mentioned previously, these programs will offer an opportunity to monitor the operation of the installed Muskeg River Mine tailings facilities, particularly the performance of thickened tailings and TSRU tailings. The initiatives planned for the Muskeg River Mine include:

- co-disposing of thickened tailings with TSRU tailings
- creating NST without using gypsum
- developing capping techniques to support early reclamation

Co-Disposal of Thickened Tailings with TSRU Tailings

The current operating procedure calls for TSRU tailings to be deposited below a water cap. Further studies have suggested that solvent recovery will be at a high enough level that the emissions from beaching the TSRU tailings will be negligible. Preliminary tests have shown that the thickened tailings and TSRU tailings streams could be combined, and that a non-segregating deposit could be formed. Shell plans a field trial to thicken TSRU tailings and combine them with thickened tailings.

Creating Non-Segregating Tailings Without Using Gypsum

By not adding gypsum to CT, better water quality is maintained and capital and operating costs are decreased. The parameters that will define field programs for creating NST are:

- generating a homogeneous deposit
- developing sufficient internal shear strength to support a capping layer

Developing Capping Techniques to Support Early Reclamation

Tests will be conducted to establish methods to physically place the cap layer without denigrating the integrity of the underlying deposit. Testing on a large-scale deposit with pore pressure monitoring will be undertaken during the ongoing operation of the demonstration plant.

**APPLICATION FOR APPROVAL OF THE
PIERRE RIVER MINE PROJECT
VOLUME 2: PROJECT DESCRIPTION**

WATER SYSTEMS

SCOPE

The water systems required for the Pierre River Mine include:

- river water
- raw water
- recycle water
- hot water
- gland water
- potable water
- sanitary wastewater

ATHABASCA RIVER WATER

River Water Supply

Raw water for the Pierre River Mine will be supplied from the Athabasca River. The river intake structure will be located on the west side of the Athabasca River, 3 km north of Sled Island. A bank-style intake structure, sized for a maximum withdrawal rate of 4.72 m^3/s, will be used.

Water Pumping and Piping System

The river water pipeline for the Pierre River Mine will be about 9 km long, and will extend from the proposed Athabasca River intake structure to the raw water pond. The pipeline will run south from the intake, parallel to the Athabasca River, entering the Pierre River Mine site on the northeast side.

PROCESS WATER SUPPLY AND DISTRIBUTION

The process water supply and distribution systems will:

- be designed as closed-loop circuits
- draw water for the plant's requirements, from either the:
    - raw water pond
    - recycle pond

RAW WATER SYSTEM

Water from the Athabasca River will be pumped into the raw water pond. The capacity of the raw water pond will be based on a full shutdown of the water intake and operation of the plant for about one day. The raw water pond will be designed according to the Canadian Dam Association and Alberta Environment guidelines. The raw water pond and other ponds at the project site will have, as a minimum:

- 1 m for freeboard
- 1 m for silt accumulation
- 1 m for ice cover

Clean water from the raw water pond will feed the water distribution systems to meet the requirements of the mine and extraction plant for process and other uses.

The raw water system will supply water to two distribution systems:

- fire water
- a water system to supply water to meet all other plant and mine requirements, including:
    - boiler feedwater
    - gland seal water
    - dust suppression
    - vehicle cleaning

The water discharge from these activities will be transported to the recycle water pond.

RECYCLE WATER SYSTEM

Recycle Water Pond

The capacity of the recycle water pond will be 142,000 m^3. The capacity is based on full shutdown of the water input and operation of the plant for about 12 hours.

The recycle water pond will collect:

- Athabasca River makeup water
- water reclaimed from the tailings pond
- surface runoff from the plant and other developed areas
- mine wall seepage
- cogeneration plant effluent
- boiler blowdown
- backwash water from the potable water reverse osmosis (RO) system
- treated sewage

Water from the basal water system will be fed directly into the ETDA, and will eventually enter the recycle water pond through the water reclaimed from the ETDA. The recycle water pond will be sized to hold all of the process water, plus the plant area runoff from the 1-in-100-year, 24-hour precipitation event.

PIPING SYSTEM, DUMP LINE AND COOLING TOWER

The recycle water piping system will be used to supply the two froth treatment trains.

The recycle water system will also include a line to direct surplus warm (55ºC) recycle water, returning from the froth treatment plant, to the recycle water pond. To ensure that the temperature of the recycle water in the pond does not exceed 23ºC, a cooling tower will be used to cool the surplus water during the summer.

The cooling tower will consist of 18 individual cells. Dirty and corrosive recycle water will be directed through cell tube banks made of duplex stainless steel. Air will be drawn over the tube banks by cooling fans, and clean water will be sprayed onto the tube banks by circulating pumps mounted in an integral sump attached to each cell.

The recycle water distribution system will also include a pipeline to direct surplus warm recycle water, returning from the froth treatment plant, to the recycle water pond. To ensure that the temperature of the recycle water in the pond does not exceed design temperature, a cooling tower will be installed to cool the surplus warm water during the summer.

The recycle water pond will supply water to two distribution systems:

- an integrated process stream heating and cooling system
- a plant and tailings flush and density control system. Water from this system will be used to:
    - flush the plant and the tailings line, when required
    - control the rheology of the tailings, if the solids content exceeds the design level

All water supplied by the two systems will eventually be directed to the tailings disposal area.

HOT WATER SYSTEM

Hot Water Tank and Pumps

The Pierre River Mine hot water system will consist of a hot water tank, hot water pumps and a pumphouse. The hot water system will be located adjacent to

Hot Water Tank and Pumps (cont'd)

the cogeneration plant to minimize the distance that the steam and condensate will be transported.

Condensate coolers will be provided, to cool condensate from steam users and preheat the water feeding the extraction water heaters. Warm recycle water returning from the froth treatment plant will be used to cool the condensate.

Extraction Water Heaters

Extraction water heaters will be provided to heat the warm recycle water from the condensate coolers to the final required temperature for use in the hot water system.

The extraction water heaters will be located adjacent to the hot water tanks.

Supply Lines

An above-ground insulated hot water supply line will connect the hot water pumphouse to the breaker building.

GLAND WATER

Gland water will be withdrawn from the raw water pond. A connection to the recycle water system will allow recycle water to be used as gland water during periods of low flow in the Athabasca River.

POTABLE WATER

Potable water for the Pierre River Mine will be withdrawn from the Athabasca River.

Water withdrawn from the Athabasca River is subject to periods of high total suspended solids (TSS) and organic content. The ultrafiltration membranes reduce the TSS in the river water feed to less than 1 nephelometric turbidity unit (NTU), and coagulation is optimized to reduce organic contaminants by up to 75%.

WASTEWATER TREATMENT

The estimated domestic sewage flow from the construction camp is 750 m^3/cd. This will be reduced to 150 m^3/cd during operations.

During operations, the sources of domestic sewage will include the:

- truck-shop complex
- warehouse

- plant operations building
- ore preparation operations building
- plant maintenance building
- administration building

The sewage treatment system will be designed and operated to meet provincial standards and guidelines. The wastewater from the sewage treatment plant will be discharged to the recycle pond for reuse in the processing plant. The quality criteria for the final effluent will be consistent with the intended reuse. Effluent will not be discharged to the environment.

WATER TREATMENT CHEMICAL SUPPLY

All solid or liquid chemicals used in water treatment will be transported by truck to the project site (see Waste Management, Section 11, Table 11-1).

ELECTRICAL POWER SOURCES

A maximum power demand of 200 MW per day will be required for the Pierre River Mine. This demand will normally be satisfied by power generated on site using an 85 MW natural-gas-fired cogeneration plant and a 115 MW asphaltene-fired cogeneration plant (AER). The rated voltage will be 18 kV.

Any excess power produced at the Pierre River Mine cogeneration plants will be exported to the Alberta Interconnect System (AIS). During periods of shutdown for maintenance, electrical power will be supplied from the AIS.

Table 8-1 shows the estimated annual power generation and consumption data for the first 10 years of the project.

Table 8-1: Initial Annual Operating Electrical Power Generation and Consumption

Component	Quantity
Gas turbine generator (GTG)	85 MW
Asphaltene-fired cogeneration plant (i.e., asphaltene energy recovery unit [AER])	115 MW
Total generation	200 MW
Cogeneration plant station services	5 MW
Main plant	165 MW
Total consumption	170 MW
Daily power excess	5.0 MW
Total annual generation	1,550 GWh
Total annual gross consumption	1,265 GWh

The annual data reflects an availability factor of:

- 85% for the extraction plant
- 93% for the gas turbine generator
- 85% for the AER

GAS-FIRED COGENERATION PLANT

The gas-fired cogeneration plant will consist of two major components:

- an 85 MW combustion gas turbine generator (GTG)
- a heat recovery steam generator (HRSG)

The gas-fired cogeneration plant will be designed to meet the Canadian Council of Ministers of the Environment (CCME) emission guidelines for stationary combustion turbines. Similar sized gas-fired cogeneration units have been successfully operated at the Muskeg River Mine.

ASPHALTENE-FIRED COGENERATION PLANT

Shell is considering several options for one of its Pierre River Mine cogeneration plants, to provide both steam and electricity. The options include:

- an asphaltene energy recovery (AER) unit (see Figure 8-1) with conventional boiler technology

- a natural-gas-fired cogeneration facility

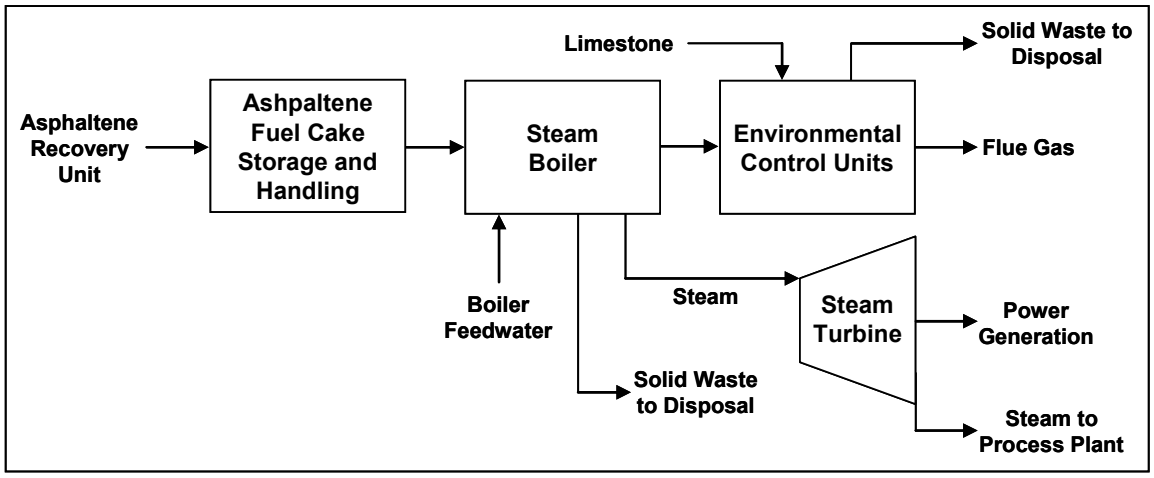


Figure 8-1: Asphaltene-Fired Cogeneration Plant

The AER technology uses what would otherwise be a waste stream, as a source of energy. For the Pierre River Mine, this would reduce the overall dependence on natural gas as a source of energy. Shell is evaluating further improvements to this technology, e.g., oxygen firing, which could reduce the overall emissions to the equivalent of gasification with future carbon capture-ready option.

The cogeneration plant will include a backpressure steam turbine that will be fed from an asphaltene-fired pulverized fuel boiler. The demand for high-pressure (HP) steam will be met through controlled turbine extraction. Low-pressure (LP) steam will be provided from the turbine exhaust.

Boiler flue gas will be treated in a series of environmental units to achieve acceptable emission levels for sulphur dioxide (SO_2), oxides of nitrogen (NO_x), and particulates. The gross-rated electrical output for the steam turbine is about 150 MW.

The asphaltene-fired cogeneration plant will include:

- a storage facility for asphaltene fuel cake
- steam delivery, including:
    - a pulverized fuel boiler
    - a fuel handling and firing system
- environmental control units, including:
    - selective catalytic reduction
    - limestone handling and preparation
    - a mercury control system
    - a baghouse
    - wet flue gas desulphurization (FGD) and wet electrostatic precipitator (WESP)
    - solid waste handling systems
- a steam turbine facility that includes a:
    - steam turbine generator
    - process steam system
    - boiler feedwater system
    - condensate and makeup system

Asphaltene Fuel Cake Storage Facility

The asphaltene fuel cake produced in the asphaltene recovery unit will be dewatered and conveyed by a conveyor belt to the fuel cake storage facility. The asphaltene fuel cake will be stored in four silos located above the boiler. Each silo will feed a dedicated fuel feeding system. The silo system will have the capacity to store sufficient fuel to keep the boiler operating for four hours at full capacity.

Steam Delivery

Steam Boiler

A pulverized fuel boiler that burns asphaltenes will be used to combust the asphaltene fuel cake. The boiler design will be conventional, similar to boilers

Steam Boiler (cont'd)

used to combust solid fuel. The design of the boiler furnace will be based on the characteristics of the asphaltene fuel, such as particle size, heat content, abrasiveness and friability.

The hot flue gas will heat boiler feedwater indirectly before the flue gas leaves the boiler, producing a superheated fluid from which steam will be generated.

High-pressure steam will flow from the boiler to the steam turbine for power generation, and will then be exhausted for use in the process plant as low-pressure steam. A small stream of high-pressure steam will also be extracted from the steam turbine for use in the process plant.

The combustion air system for the boiler will be made up of fans, air heaters, air ducts and dampers. The combustion air will be drawn into the fans from inside the boiler house to take advantage of the warm inside temperature.

The combustion air will flow though the fans and heaters to the fuel mills where it will entrain the asphaltene fuel for transport to the furnace, exiting through the burners. The combustion at the burners will be maintained at sub-stoichiometric conditions to minimize the formation of thermal NO_x. The temperature in the furnace will range from 1,200 to 1,300°C.

The flue gas system will consist of induced draft fans, flues and dampers. The flue gas will be drawn from the boiler outlet through the combustion air preheaters and through the baghouse by the induced draft fans. The flue gas will exit the induced draft fans and flow to the stack through the wet flue gas desulphurization and wet electrostatic precipitation unit.

Fuel Handling and Firing System

The fuel from the asphaltene fuel storage silos will flow, by gravity, through fuel feeders on the bottom of the silos. The feed rate will be controlled, based on the steam flow demand from the steam turbine. Each fuel feeder will feed a dedicated fuel mill, where the asphaltenes will be dried by hot air and transported to the furnace burners.

The boiler will also be equipped with auxiliary burners capable of firing natural gas to about 30% of the boiler's rated capacity. These auxiliary burners will be used to start up and shut down the boiler.

Environmental Control Units

Environmental control units that incorporate the following will be installed:

- selective catalytic reduction
- limestone handling and preparation
- a mercury control system
- a baghouse
- a wet FGD and wet electrostatic precipitator

- solid waste handling systems
- a stack
- a steam turbine facility
- a boiler feedwater system
- a condensate and makeup system

Emerging environmental control technology will continue to be evaluated as to its applicability to, and capability to be incorporated into, the design.

Selective Catalytic Reduction

The selective catalytic reduction (SCR) system will store, prepare and inject reagent into the boiler flue gas upstream of the catalyst bed, to reduce NO_x to elemental nitrogen and water. The configuration assumes that urea will be used as the reagent and that the urea will be converted to ammonia, as needed, before injection.

The primary components of the SCR system include:

- dry urea unloading and storage
- a urea dissolver system and storage
- a urea to ammonia conversion system
- an ammonia metering and delivery system
- an ammonia injection grid
- catalyst and reaction housing

Limestone Handling and Preparation

The limestone handling system will receive, stockpile and prepare limestone for delivery to the wet FGD plant. Limestone will be received in a granular form that will require storage and preparation facilities.

The limestone will be mixed with water and fed into a grinding mill. Lime slurry from the mill will be pumped to the FGD plant.

Mercury Control System

A powdered activated carbon (PAC) system will be used to capture mercury. The PAC sorbent will capture vaporized mercury as it contacts the flue gas, especially as the PAC is collected on the fabric filters in the baghouse. Efficiency of greater than 90% removal of mercury is expected.

Baghouse

The primary function of the baghouse will be to capture particulates from the flue gases.

The flue gas will travel from the outside to the inside of the filter bags, and the cleaned flue gas will pass through a tube sheet on which the bag cage assemblies will be supported. Solids will be collected in hoppers.

Wet FGD and Wet Electrostatic Precipitator

The wet FGD and wet electrostatic precipitator will be required to capture SO_2 and SO_3 acid mist from the boiler.

The wet FGD unit will consist of a conventional spray-tower-type wet-limestone forced oxidation system. Flue gas will be contacted in an absorber vessel with limestone slurry, and the SO_2 will be converted to gypsum.

Flue gases from the FGD will enter the wet electrostatic precipitator, where fine particulate matter will be removed. The WESP will consist of:

- tubular collection electrodes
- ionizing (discharge) electrodes
- a high voltage power supply and voltage controller
- a wash water system

Solid Waste Handling Systems

Fly ash will be collected from the air heater and baghouse hoppers. The fly ash will be transported pneumatically to the ash storage silo. The fly ash will be transported by truck to the ETDA. Ash collected in the bottom of the furnace will be transferred out of the furnace hopper, ground down by a clinker grinder and conveyed to a storage silo. The bottom ash will be transported by truck to the ETDA.

Stack

The stack will consist of a single concrete shell with a single flue that will be designed for saturated conditions imposed by the FGD unit. The stack height will be about 150 m.

Steam Turbine Facility

Steam Turbine

A backpressure steam turbine, fed from a steam boiler, will provide electrical power and steam for use in the process plant. High-pressure steam demand will be met through controlled turbine extraction at 3,800 kPa. Low-pressure steam demand will be provided from the turbine exhaust at 1,140 kPa.

Process Steam System

Process Steam Desuperheaters

High and low-pressure steam from the steam turbine will require desuperheating to achieve saturated steam conditions. Direct contact spray water, provided from the outlet of the boiler feedwater, will be used for controlled cooling.

Turbine Bypass and Letdown Station

A turbine bypass and steam pressure letdown station will be provided to allow continued steam generation from the boiler during turbine outages.

Steam Piping to Process Plant

High and low-pressure steam supply lines from the cogeneration plant will be tied into the process plant.

Boiler Feedwater System

Deaerator

The deaerator will remove dissolved oxygen and carbon dioxide in the boiler feedwater and will provide open, direct-contact feedwater heating. The deaerator internals will provide mechanical agitation and effective scrubbing.

Boiler Feedwater Pumps

The boiler feedwater pumps will consist of three 50% multistage pumps.

Condensate and Makeup System

Condensate Tank

Condensate returning from the process plant will be stored in a day tank that will be sized to provide three hours of storage.

Condensate Transfer Pumps

Condensate transfer from the storage tank to the deaerator will be provided by two 100% condensate pumps.

Water Treatment Plant

A water treatment plant will provide demineralized water for the boiler feedwater. The water treatment plant will include clarification, filtration, cation and anion treatment, and mixed bed exchangers for demineralized water production. The plant will also handle and store equipment required for regeneration chemicals and effluent.

Makeup Water Tank

Demineralized makeup water will be stored in a day tank that will be sized for three hours of storage.

Makeup Water Pumps

Two 100% pumps will transfer makeup water from the storage tank to the deaerator.

ELECTRICAL POWER DISTRIBUTION

Electrical power will be distributed through:

- a 25 kV cable on pipe racks within the main process plant area
- 72 kV overhead lines in the mining and tailings areas

Because of higher reliability needs, utility and froth treatment areas will be provided with dual feeders. Other areas, including those at the 600 V level, will be fed by a radial, single-feed system.

The 72 kV distribution system for the mining and tailings areas will be designed to service the entire project, as well as future sustaining capital projects. At incremental periods, 240 kV and 72 kV lines will be relocated, as needed, to facilitate mining.

Emergency generators will be provided at locations that require power for critical loads during a power outage.

NATURAL GAS

Operations' Requirements

The Pierre River Mine will require natural gas for:

- one 85 MW GTG
- one HRSG
- three 675 GJ/h package steam boilers
- building heating

Natural gas requirements for normal operation of the Pierre River Mine will be 2,000 GJ/h. However, the natural gas system will be sized to supply about 5,000 GJ/h, which is sufficient to supply all of the gas-fired units. This will allow for maintenance of the asphaltene-fired boiler without affecting bitumen production.

Table 8-2 lists the estimated projected heat demands and sources for several operating scenarios. Process heat will primarily be supplied from the cogeneration plants. Supplemental heat will be provided by gas firing the heat recovery steam generator and from the stationary steam boilers.

Table 8-2: Heat Demands for Pierre River Mine Operations

Quality of Ore Processed	Supply		Total Demand (GJ/h)
	Asphaltene Fired Boiler (GJ/h)	Natural Gas-Fired Equipment (GJ/h)	
Winter high grade	1,800	1,760	3,560
Winter average grade	1,800	1,600	3,400
Winter low grade	1,800	1,620	3,420
Summer high grade	1,800	1,260	3,060
Summer average grade	1,800	1,000	2,800
Summer low grade	1,800	220	2,020

Fuel Gas Supply

Pipeline-quality, high-pressure natural gas will be supplied from the local gas pipeline systems by connecting to the Inter Pipeline Fund distribution pipeline that currently runs parallel to Highway 63.

The natural gas conditioning system will provide all of the fuel gas. This system will generally consist of:

- 100% duty fuel gas inlet coalescing filters
- a natural-gas-fired indirect contact fuel gas heater
- 100% duty fuel gas pressure reducing trains
- a duplex filter for the GTG fuel gas

Blanket Gas Distribution

Blanket gas for the new process units and gas for the flare stack pilot burner and building heating will be taken from the dried low-pressure natural gas system.

ASPHALTENE FUEL

The asphaltene recovery unit (see Section 6) will recover asphaltenes from the TSRU tailings in the form of a solid fuel cake. The solid fuel cake will consist of:

- a loss of ignition (LOI) combustible species
- an ash or non-combustible species
- residual water content

The solid fuel produced from the asphaltene recovery system will be put into short-term storage, then sent to the asphaltene cogeneration plant.

SCOPE

The auxiliary utilities required for the Pierre River Mine process plant include:

- instrument and utility air
- steam
- nitrogen
- diesel and gasoline

INSTRUMENT AND UTILITY AIR

The instrument and utility air required for maintenance use do not change significantly from winter to summer.

Instrument and utility air will be supplied on site by two conventional industrial air plants, with a third plant on standby.

Separate low-pressure piping networks will distribute instrument and utility air.

STEAM

Total steam demand is expected to be 3,560 GJ/h. This demand will be supplied by:

- the asphaltene boiler
- the heat recovered from the GTG
- the HRSG installed with the gas turbine
- three 675 GJ/h gas-fired steam boilers

If one of the cogeneration plants is shut down during the summer, this configuration of equipment will allow the plant to operate at full capacity. An unplanned winter shutdown would require the plant to cut back on production. The total capacity of the system will be 4,100 GJ/h equivalent steam.

Steam will be distributed and used for:

- heating extraction water
- deaerating froth

STEAM (cont'd)

- heating the froth trash screen water
- recovering solvent
- heating gland water
- providing utility steam

NITROGEN

Nitrogen will be used for purging equipment in the froth treatment plant.

Nitrogen will be delivered to the Pierre River Mine by truck, when required, from such areas as Fort McMurray or Edmonton.

Nitrogen will be distributed from the truck to on-site users by temporary hoses or piping. A permanent nitrogen distribution network is not planned. Purge gas nozzles will be installed on vessels and tanks to allow them to be blanketed, as necessary.

DIESEL AND GASOLINE

Diesel and gasoline fuel will be required for:

- mine equipment
- ore trucks
- light-duty vehicles

The fuel will be delivered to the site in tanker trucks and stored in above-ground tanks near the site.

The tanks will be located within impermeable berm systems to contain the diesel or gasoline, if there are any leaks.

SCOPE

The infrastructure required for the Pierre River Mine includes:

- utility corridors
- an access road
- a new bridge
- fire protection
- communication equipment

UTILITY CORRIDORS

Four utility corridors to the Pierre River Mine site are required for:

- a raw water pipeline
- a natural gas pipeline
- a diluted bitumen (dilbit) product and diluent return pipeline
- an electrical power line

Raw Water Pipeline Corridor

The raw water pipeline will extend 11 km from the Athabasca River to the Pierre River Mine site.

Natural Gas Pipeline Corridor

The natural gas pipeline will tie into the Inter Pipeline Fund distribution pipeline that runs parallel to Highway 63. The natural gas pipeline corridor will follow the site access road and cross over the Athabasca River on the new access bridge. The pipeline corridor will enter the site on the east side of the plot and end at the gas conditioner.

Dilbit and Solvent Supply Pipeline Corridor

A dilbit and solvent pipeline corridor will extend from the Pierre River Mine site to the tank farm. The following pipelines will be routed within this corridor:

- a dilbit pipeline
- a solvent return pipeline

Dilbit and Solvent Supply Pipeline Corridor (cont'd)

- a fire water pipeline
- a nitrogen pipeline

From the tank farm, the corridor containing the product and solvent supply pipeline will extend out to the access bridge. The pipelines will be suspended under the bridge and tie into diluted bitumen and solvent return lines to Scotford.

Electrical Power Line Corridors

The electrical power distribution corridor will be 30 m wide and will tie into the proposed ring main that will interconnect to the provincial distribution system.

ACCESS ROAD

Access to the Pierre River Mine site will be via an extension of Highway 63 along the current Fort Chipewyan winter road.

To reach the site access road, about 27.8 km of the Fort Chipewyan winter road will require upgrading. The proposed access road from the Highway 63 extension to the site boundary will be about 3.5 km long.

This option provides the shortest access roadway to the site.

NEW BRIDGE

A new permanent bridge over the Athabasca River will be required to access the Pierre River Mine site.

The bridge design loading will be designed to provide for:

- live load classification CL-800 Highway Traffic loading according to the Canadian Highway Bridge Design Code CAN/CSA S6-00
- ice loading
- overhead or special vehicle loading, consisting of a double wide, Scheuerle trailer and tractor that has a gross vehicle weight of 1,024 t
- three 915 mm-diameter process pipelines

FIRE PROTECTION

Fire Water Supply

A fire water system, designed for a single fire event, will service the project.

Fire water and jockey pumps, required for maintaining pressure in the fire water system, will be installed in the raw water pumphouse wet well. These pumps will have sufficient capacity to service the requirements of the project.

Fire Water Distribution

The Pierre River Mine fire water distribution system will consist of a series of distribution loops and hydrants. The distribution loops will service the:

- froth treatment area, including the foam package, to accommodate the settlers
- dilbit and solvent tanks, including the foam package
- extraction and tailings area, including extensions of the breaker and froth screening facilities
- ore preparation area
- steam generation building
- water treatment building extension

A standpipe and hose systems will be provided to buildings or building extensions, as required, to meet the building codes.

COMMUNICATION EQUIPMENT

A two-way radio system will be established for mine and extraction plant operations. Radio power distribution facilities will be incorporated into building structures. A standalone radio tower will not be required. Telephone communication lines will be run below ground, inside the utility corridor.

AUXILIARY BUILDINGS

SCOPE

Auxiliary buildings required to support operations at the Pierre River Mine, include:

- a mine services facilities building
- a warming shed
- an administration office complex
- a plant administration office complex
- a plant operations building
- a plant maintenance building
- a plant warehouse and storage area
- a gatehouse and weigh scale
- a truck wash facility and tire repair shop
- a bulk lube facility
- a core testing facility
- a light vehicle wash building and gasoline island

MINE SERVICES FACILITIES BUILDING

The mine services facilities building will be located close to the ore preparation area. The building will include:

- repair bays with service cranes for heavy vehicles and general maintenance
- welding and component repair shops
- a warehouse and tool crib area
- offices for mine operations and maintenance staff
- the mine dry, e.g., locker room and shower facilities

The heavy-vehicle bays will be designed to accommodate the largest haul truck expected to be used in the mining fleet, which is currently a 327 t (520 t gross weight) haul truck with the bed raised. The warehouse will provide heated storage space for small supplies and other goods requiring protection from the elements. Large objects and bulk materials unaffected by weather will be stored within a fenced area outside.

WARMING SHED

A warming shed will be provided for parking infrequently used mobile equipment. The building will be heated to maintain a minimum internal temperature of 0ºC. The floor will be compacted gravel to support the heavy equipment.

ADMINISTRATION OFFICE COMPLEX

A two-storey administration office complex will house the operations management and administrative staff and security and emergency response facilities. The building will be centrally located within the plant site. A security facility will be integrated within the administration office complex.

An emergency response facility will also be incorporated within the administration office complex and will include:

- a two-bed emergency clinic
- a covered bay for a fire truck
- a covered bay for an ambulance
- supporting offices
- fire apparel storage
- washrooms

PLANT OPERATIONS BUILDING

The plant operations building will consist of:

- offices for engineering and operations staff
- locker rooms for operations personnel
- the plant control room
- hydrocarbon and clean laboratories
- the main shift-change operations room
- a training room
- the control room
- two laboratories

The hydrocarbon laboratory will be on the ground floor, and will include:

- sample receiving and storage
- offices
- a safety and meeting room

The clean laboratory will be on the second floor, and will include:

- a laboratory with equipment for environmental and water sampling tests
- a storage area
- an office

PLANT MAINTENANCE BUILDING

Maintenance and on-site repairs for process plant equipment will be carried out separately from the mine equipment maintenance. The plant maintenance work will be performed in a dedicated building.

The two-storey plant maintenance building will be built near the process plant.

The ground floor will house:

- separate shops for:
    - pipe fabrication
    - welding
    - machining
    - electrical repair
- an area for tool cribs and tool cart storage

The second floor will house:

- offices
- a lunchroom
- washrooms
- a clean instrument repair shop

PLANT WAREHOUSE AND STORAGE AREA

A plant warehouse and storage area will be located close to the plant operations building. It will provide warehousing and covered storage space to support the process and cogeneration plants during construction and operation. Insulated and heated warehouse space with a concrete slab-on-grade floor will be available for all equipment spares requiring indoor heated storage.

GATEHOUSE AND WEIGH SCALE

A gatehouse and weigh scale will be located on the plant access road between the Athabasca River bridge and the plant site. The gatehouse will house security personnel, who will restrict and control access to the property. The truck weigh scale outside the gatehouse will be used for weighing materials delivered in bulk to the site.

TRUCK WASH FACILITY AND TIRE REPAIR SHOP

The truck wash facility and tire repair shop will be located adjacent to the mine services facilities building in the ore preparation area. A single bay will be used for washing mine vehicles. Two bays will be used for repairing the tires of mine

TRUCK WASH FACILITY AND TIRE REPAIR SHOP (cont'd)

vehicles. Oily water will be hauled offsite for third-party disposal. Residual water will be recycled to the ETDA.

BULK LUBE FACILITY

A bulk lube storage facility will be incorporated to contain the various mine mobile equipment lubricants. All lubricants will be stored in tanks.

CORE TESTING FACILITY

The core testing facility will include:

- a truck bay
- a geotechnical log area
- a quality assurance laboratory
- offices for geotechnical and geological personnel

LIGHT VEHICLE WASH BUILDING AND GASOLINE ISLAND

The light vehicle wash building will consist of a single wash bay and service room for light vehicles. A gasoline island will be located adjacent to the building. Oily water will be hauled offsite for third-party disposal, and residual water will be recycled to the ETDA.

**APPLICATION FOR APPROVAL OF THE
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MATERIAL BALANCES

SCOPE

The Pierre River Mine has been designed with two process trains to produce 31,800 m^3/cd (200, 000 bbl/cd) of bitumen. This section summarizes the overall material, heat and energy balances for the Pierre River Mine.

MATERIAL BALANCE SCOPE

Material balances were developed for:

- solids
- water
- bitumen
- solvent

The Pierre River Mine material balance for a bitumen production rate of 31,800 m^3/cd (200,000 bbl/cd) is shown in:

- Figure 9-1, on a tonnes per hour (calendar day) basis
- Figure 9-2, on a tonnes per hour (stream day) basis

PROCESS MEASUREMENT SYSTEMS

The necessary measurement systems and instrumentation to ensure that operations can be effectively and efficiently managed will be installed in the Pierre River Mine processing facilities.

The emphasis will be on process stream measurements that will enable key performance parameters in the following areas to be controlled and monitored:

- products and production
- bitumen extraction and hydrocarbon recovery
- water intake, disposal and recycle
- tailings processing and disposal
- energy consumption
- air emissions

PROCESS MEASUREMENT SYSTEMS (cont'd)

The systems and equipment used to obtain operational data for regulatory reporting will be based on sound engineering practices and will meet or exceed the:

- American Petroleum Institute (API) *Manual of Petroleum Measurement Standards*
- recognized industry-recommended practices and standards

Operational information will be reported to the EUB through the *Monthly Oil Sands Processing Plant Statement*, S-23.

OIL SANDS FEED GRADE

The Pierre River Mine processing facilities will be designed to accommodate a variety of seasonal and ore grade scenarios. The Pierre River Mine oil sands feed has been characterized as low, average and high grade. The low and high-grade ores each represent 20% of the total plant feed. The average-grade ore represents 60% of the total plant feed.

OPERATING SEASONS

For material and energy balance purposes, the operating year consists of the following seasons:

- winter
- summer

The winter season represents 58%, and the summer season represents 42% of the total annual operating time.

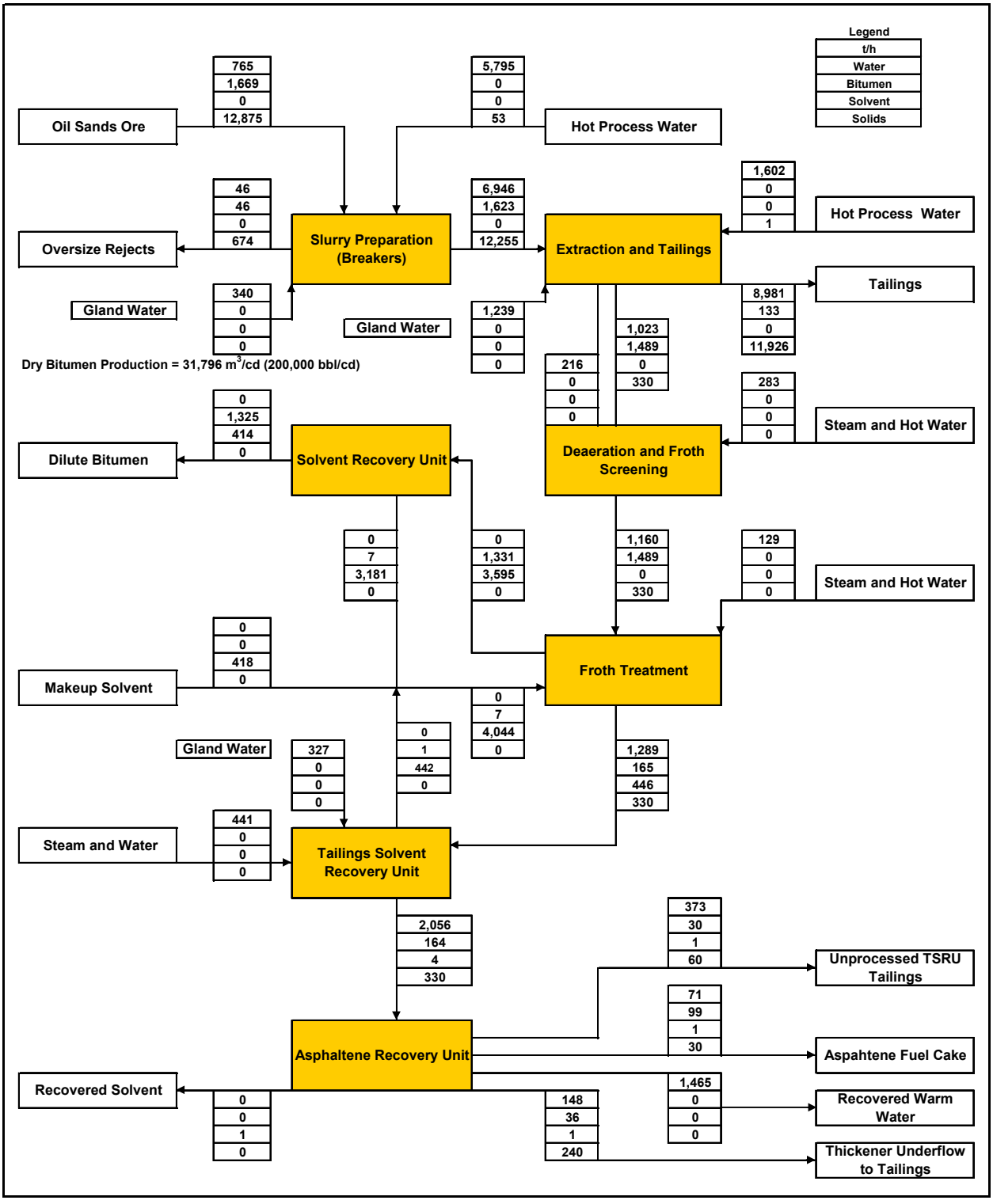


Figure 9-1: Overall Material Balance on Calendar-Day Basis

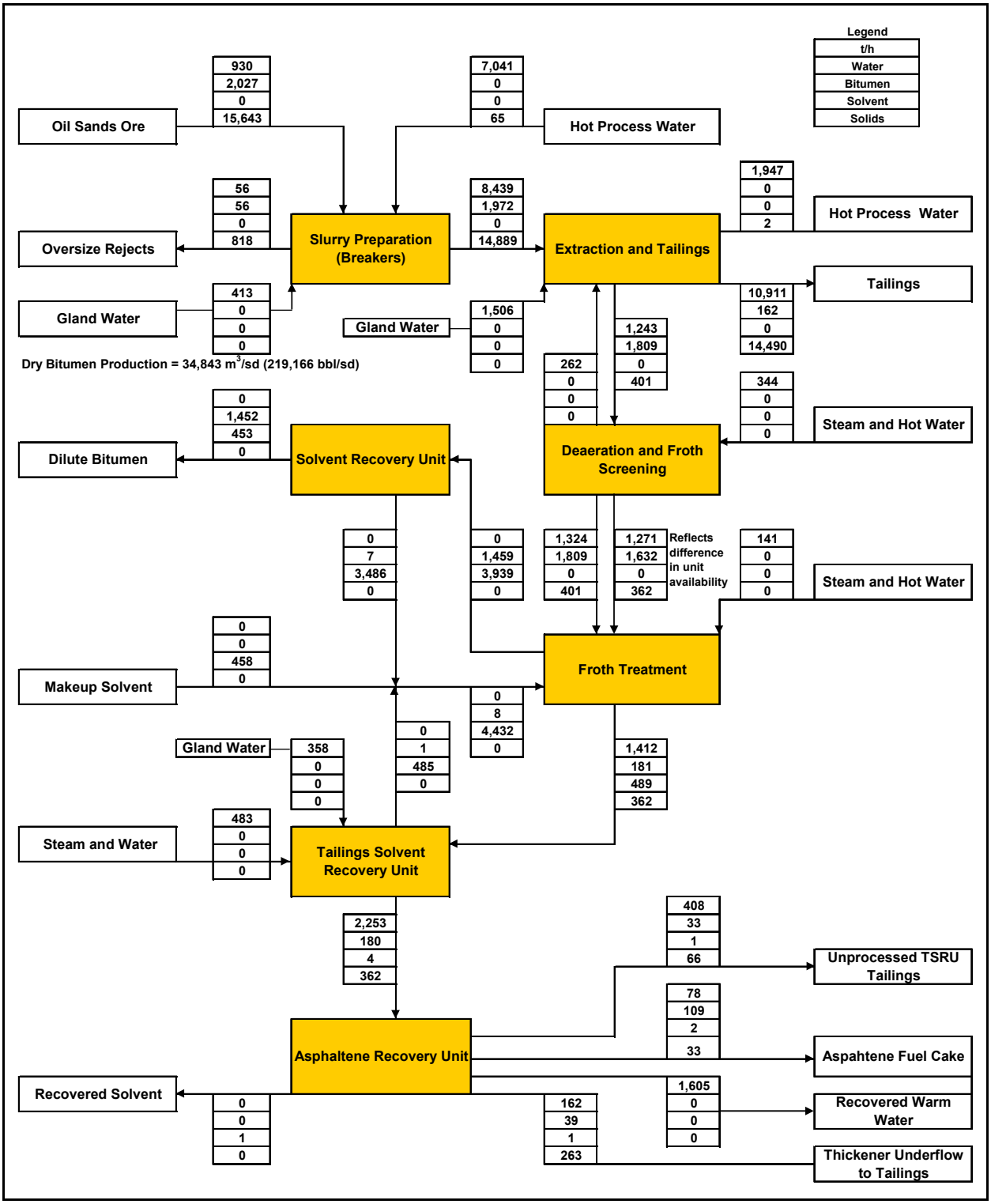


Figure 9-2: Overall Material Balance on Stream-Day Basis

OPERATING SCENARIOS

To address the expected range of conditions, energy and heat balances have been developed for a 40°C process temperature. Five operating scenarios for the Pierre River Mine are shown in:

- Figure 9-3 for winter average-grade ore conditions
- Figure 9-4 for winter coarse high-grade ore conditions
- Figure 9-5 for summer low-grade ore conditions
- Figure 9-6 for summer average-grade ore conditions
- Figure 9-7 for summer high-grade ore conditions

Energy Inputs

The energy inputs include:

- sensible heat and heating value from oil sands feed
- makeup water
- heating value from burning natural gas
- electrical power
- heating value from diesel fuel
- heating value from gasoline
- sensible heat and heating value from makeup solvent

Sensible heat is the heat absorbed or evolved by a substance during a change of temperature that is not accompanied by a change of state.

Energy Outflows

Energy outflows include sensible heat and heating values in the:

- diluted bitumen product
- froth storage
- ore rejects
- electrical power
- tailings
- blowdown
- cooling tower
- other losses

Energy Outflows (cont'd)

Table 9-1 summarizes the mine and process energy consumption per unit of bitumen, ignoring the heating value of bitumen feed and makeup solvent.

Table 9-1: Process Energy Consumption

Season	Ore Grade (wt% Bitumen)	Heating Value (GJ/m^3 of Bitumen)
Winter	Average	2.10
	Coarse high	2.09
Summer	Low	1.72
	Average	1.42
	High	1.33

MAJOR PROCESS FLOWS

Major process stream flow rates and the associated stream temperatures for the Pierre River Mine on a stream-day basis are shown in:

- Figure 9-8 for winter average-grade ore conditions
- Figure 9-9 for summer average-grade ore conditions

THERMAL ENERGY REQUIREMENTS

Table 9-2 compares the thermal energy required and the estimated natural gas consumption for the various ore types for summer and winter operation for the Pierre River Mine. This is a measure of the energy required to heat process water and create process steam, at 100% efficiency, as a function of bitumen produced. This illustrates that most of the process thermal requirements will be provided by the combustion of asphaltenes at the Pierre River Mine.

Table 9-2: Comparison of Thermal Energy Requirements

Operating Scenario	Thermal Requirement (GJ/m^3)	Natural Gas Consumed (GJ/m^3)
Winter average-grade ore	2.70	0.96
Winter coarse high-grade ore	2.59	1.08
Summer low-grade ore	2.33	0.00
Summer average-grade ore	1.82	0.00
Summer high-grade ore	1.73	0.00

The unit thermal energy requirement differs from the overall mine and process unit energy consumption, because it expresses the thermal energy requirements for conditioning, separation and froth treatment only, without regard for the source of the required heat. For example, using the asphaltenes as a source of

heat reduces the overall mine and process unit energy consumption by reducing the natural gas use, but does not change the thermal energy requirements for the process.

To further reduce the demand on the water heating system, waste heat will be recovered to process water by exchanging process water with:

- tailings to the tailings pond (preheat)
- product from the solvent recovery unit and the TSRU
- froth in the froth treatment plant

The process design will make significant use of heat exchangers to obtain the highest practical heat efficiency.

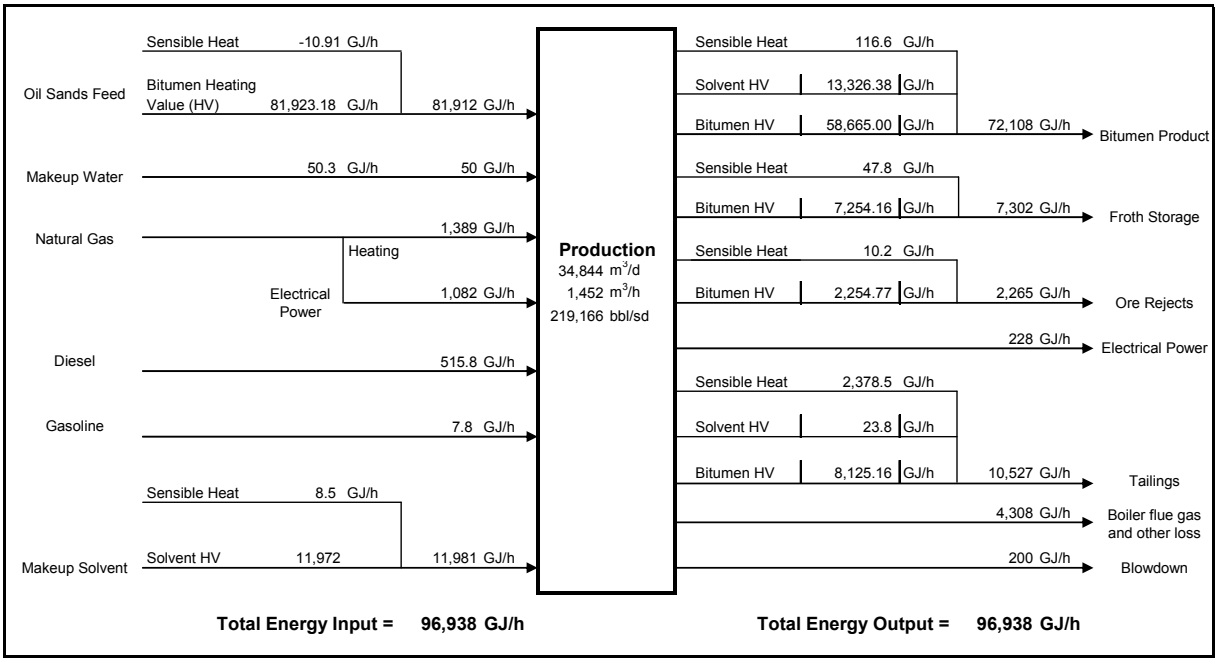


Figure 9-3: Winter Average-Grade Ore Heat and Energy Balance

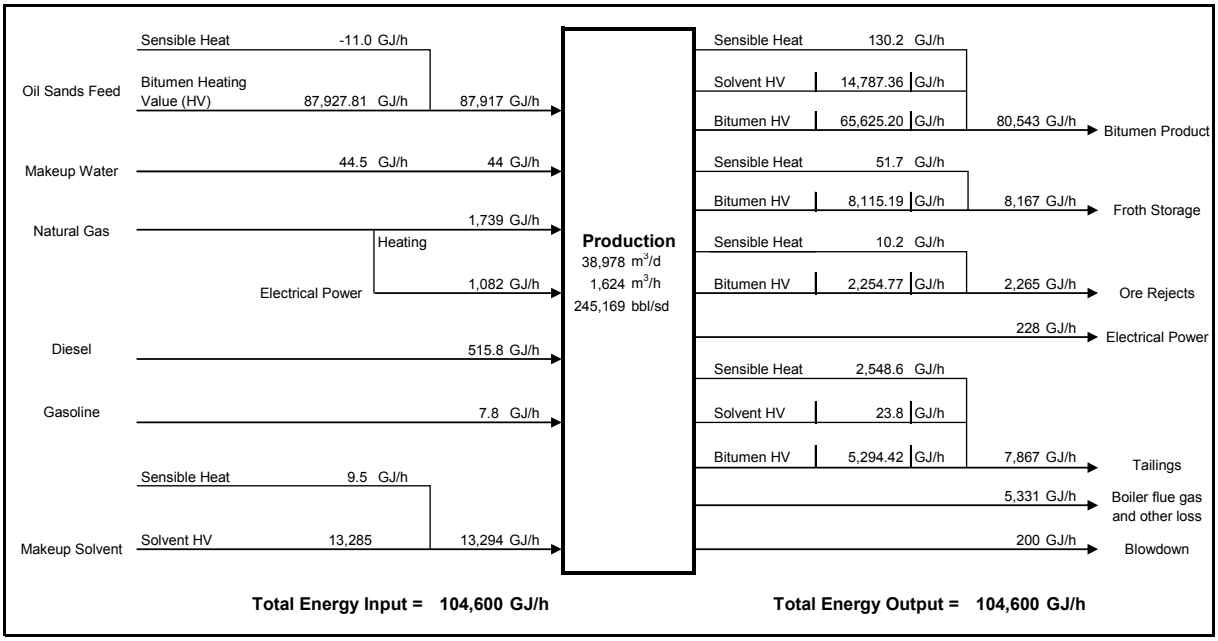


Figure 9-4: Winter Coarse High-Grade Ore Heat and Energy Balance

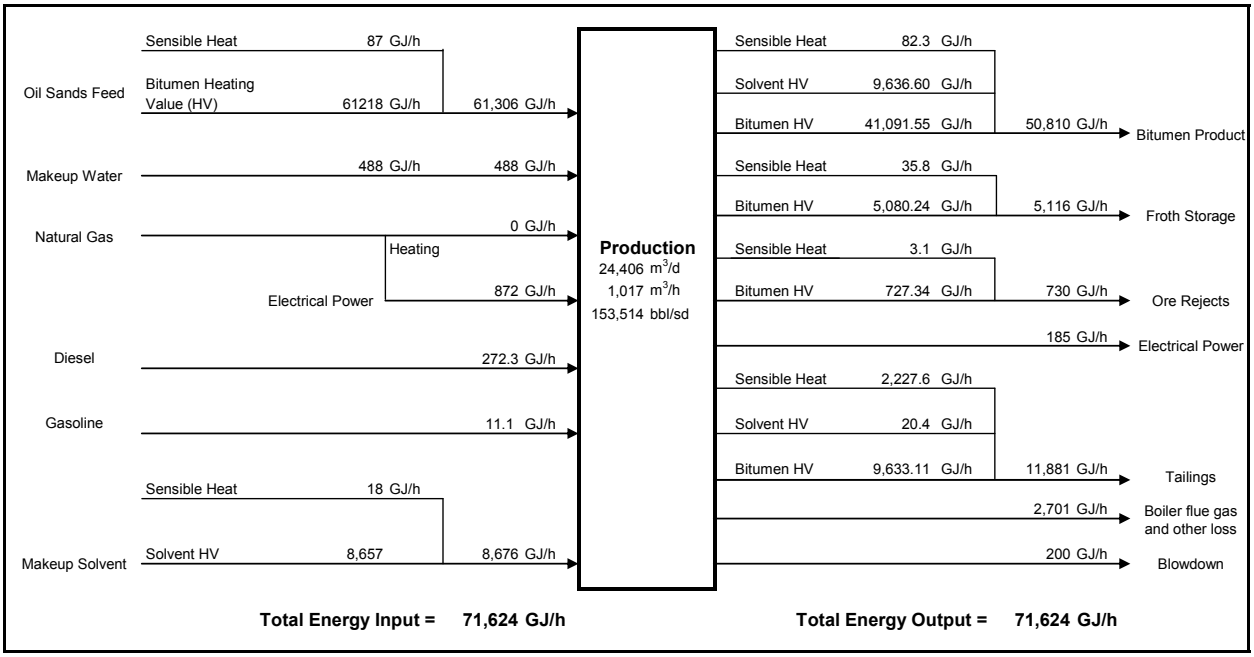


Figure 9-5: Summer Low-Grade Ore Heat and Energy Balance

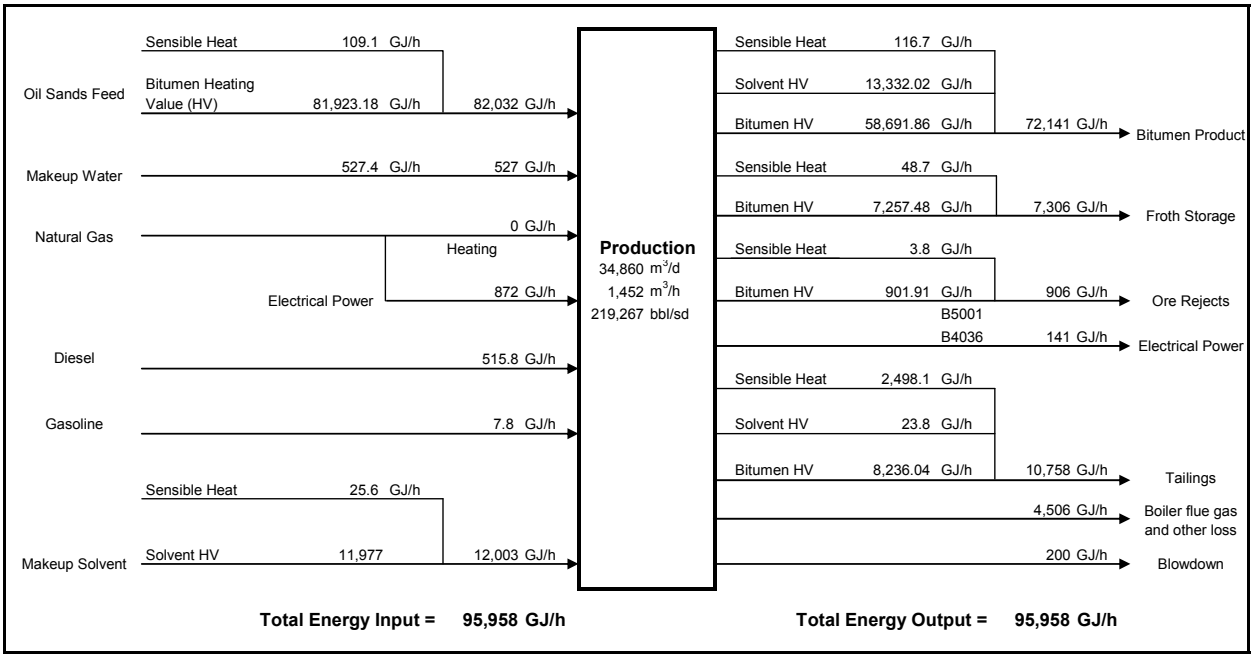


Figure 9-6: Summer Average-Grade Ore Heat and Energy Balance

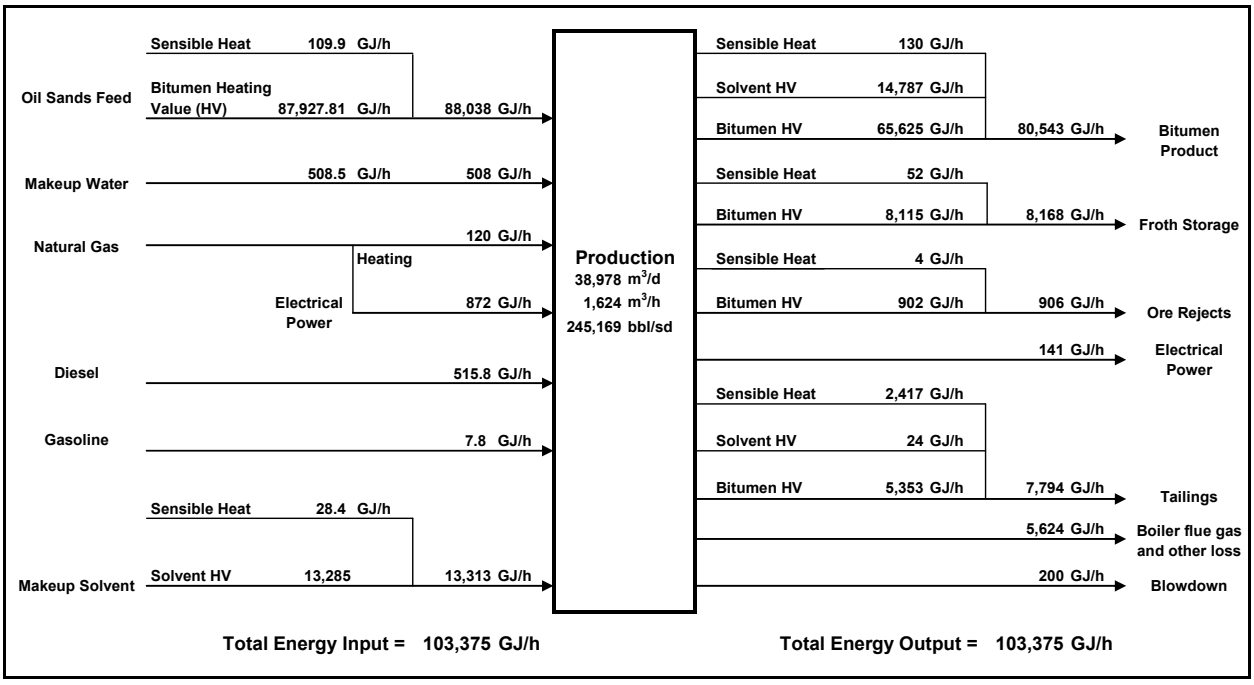


Figure 9-7: Summer High-Grade Ore Heat and Energy Balance

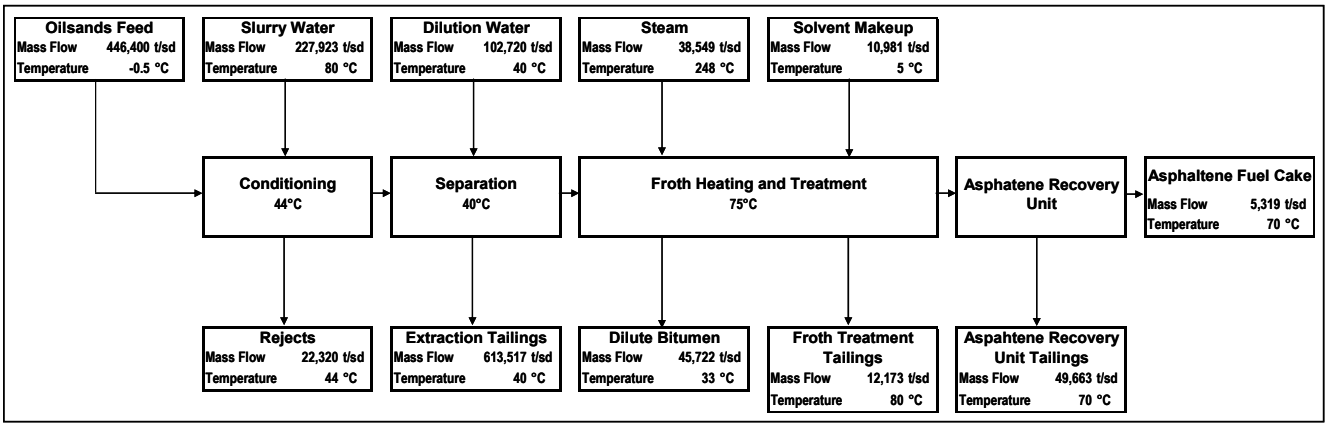


Figure 9-8: Major Process Flows for Winter Operation – Average-Grade Ore

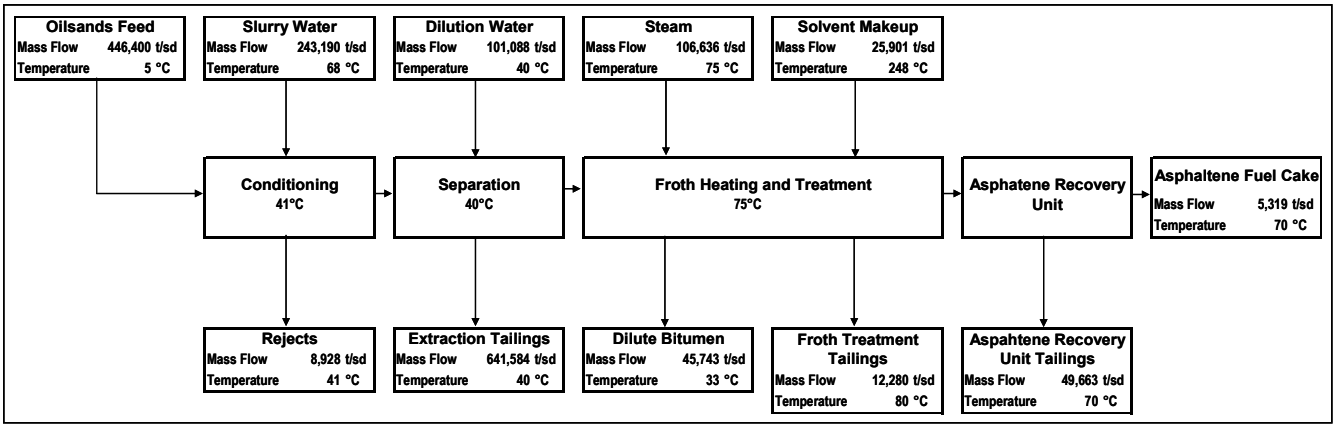


Figure 9-9: Major Process Flows for Summer Operation – Average-Grade Ore

APPLICATION FOR APPROVAL OF THE
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INTRODUCTION

SCOPE

Knowledge and experience gained from managing water at the Muskeg River mine was used to develop the water management plan for the Pierre River Mine.

This section describes water management for the Pierre River Mine, including managing:

- surface water
- groundwater
- water supply
- water balance

This section also includes information on stream diversions (see Section 10.5) and provides an application for approval under the *Water Act* (see Section 10.6).

OBJECTIVES

The development, construction, operations and water management plans for the Pierre River Mine have made water conservation a primary objective.

The objectives of the water management plan are to:

- ensure that sufficient water of the required quality is available to meet the project's requirements
- minimize the project's effects on aquatic resources in the receiving streams and lakes
- minimize the consumption of fresh water
- recycle and reuse process water to the maximum extent

WATER MANAGEMENT STRATEGIES

The water management plan and water balance will include all activities of the Pierre River Mine, and will be based on the average mine production of up to 31,800 m^3/cd (200,000 bbl/cd) by 2018.

WATER MANAGEMENT STRATEGIES (cont'd)

Water use and the quality of operating streams will be monitored regularly throughout operations to:

- ensure compliance with regulatory approval conditions
- guide continuous improvement initiatives

Site water management strategies include:

- separating and managing clean water and process-affected water streams effectively for maximum operational efficiency. Site drainage and runoff that meets water quality standards will be released to the environment. Process-affected water or water that comes in contact with oil sands and that is not suitable for discharge will be collected within a closed-circuit system and used in the process.

- allowing surface water from undeveloped areas to continue to flow to nearby streams

- managing site water inventories effectively to reduce peak raw water withdrawal from the Athabasca River

- managing water inventories to meet the requirements of the Water Management Framework

- recycling wastewater and using it in the process

- reducing losses to evaporation

- minimizing the potential for seepage to watercourses or waterbodies

SCOPE

Water management activities associated with the Pierre River Mine will include:

- dewatering muskeg and overburden for general surface drainage
- releasing clean water from the mining area
- constructing a closed-circuit industrial water system to collect process-affected water
- depressurizing the basal aquifer in the mining area

SCHEDULE OF WATER MANAGEMENT ACTIVITIES

Table 10-1 lists the schedule of the water management activities during the construction and operation of the Pierre River Mine. Muskeg drainage, overburden dewatering and basal aquifer depressurization will be incorporated into ongoing mining activities. For information on the stream diversions required for the Pierre River Mine, see Section 10.5. For additional information on the closure drainage plan for the Pierre River Mine, see EIA Volume 4B, Aquatic Resources Appendices.

Table 10-1: Schedule of New Water Management Activities

Date	Activity
2014	Begin muskeg drainage and overburden dewatering of Lease 9.
2017	Begin basal aquifer depressurizing in Lease 9.
2018	Construct clean water storage facility.
2016	Divert Eymundson Creek and Asphalt Creek around the northern boundary of Lease 9 and into the Athabasca River through an existing ephemeral creek on the south side of Lease 17. Divert First Creek around the south side of the external tailings disposal area into the same channel on Lease 17.
2016	Divert Big Creek permanently north around the external tailings disposal area and into the lower reaches of Big Creek.
2016	Divert Unnamed Creek 1 and the Pierre River permanently around the west and south boundaries of the Pierre River Mine development area into the Athabasca River.

SURFACE DRAINAGE AND CLEAN WATER RELEASE

Clean Water Management

The water management plan for clean water sources will be used to manage and control clean water within an open-circuit drainage and diversion system. Details of the surface runoff collection, conveyance and discharge systems will be developed during detailed engineering.

Clean water will be discharged to natural receiving streams to maintain aquatic ecosystems. Mine surface water that meets water quality specifications will also be discharged to receiving watercourses.

Sources of clean water will be:

- drainage from undisturbed areas
- muskeg drainage and overburden dewatering
- runoff from:
    - off-site roads
    - reclamation material stockpile areas
    - overburden disposal areas (OBDAs)

Design Criteria

The following criteria will be adopted for designing the Pierre River Mine clean water handling facilities, based on the successful performance of the existing system at the Muskeg River Mine:

- clean water conveyance systems and any water storage not contained by dams, as defined by the Canadian Dam Association (CDA), will be designed to accommodate the 100-year flood event

- all storage facilities contained by dams will be designed according to CDA guidelines

- water from undisturbed areas and cleared areas might be released to natural receiving waters without treatment in sedimentation ponds, if the conveyance facilities are designed to prevent erosion during the 10-year flood event

Muskeg Dewatering and Surface Runoff

Muskeg will be drained to prepare the Pierre River Mine site for muskeg removal and storage, overburden stripping and mining operations. Overburden is mostly made up of silt and clay, with pockets of sand. Water from muskeg drainage and dewatering will be routed through sedimentation ponds before being released to receiving streams.

Ditch drainage systems and sedimentation ponds will be constructed during initial site preparation for the mine. Sedimentation ponds for collecting and

treating muskeg drainage and surface runoff will use the same design that has been successfully demonstrated at the Muskeg River Mine.

Runoff from Roads

Surface runoff from roads will flow into nearby muskeg, where it will be naturally filtered. Runoff containing a high sediment load will, where necessary, be directed through ditching to nearby sedimentation ponds.

Runoff from Reclamation Stockpile Areas and OBDAs

Surface runoff from reclamation stockpile areas will be discharged to natural receiving waters, following treatment in sedimentation ponds.

Surface runoff from OBDAs might be routed to either the mine's closed-circuit system, i.e., drainage to the recycle pond, or to natural receiving waters after treatment, depending on the final mine configuration, topography and water quality. Before surface runoff from OBDAs is discharged to natural receiving waters, its treatment will involve sediment trapping in sedimentation ponds and oil separation.

Sedimentation Ponds

Sedimentation ponds will be constructed during site preparation. The ponds will collect muskeg drainage and surface runoff. Sedimentation ponds will have an oil separation system to manage water that has come in contact with oil sands. Oil that is separated will be collected and transported to an appropriate disposal or recycling facility. Figure 10-1 provides details of a typical sedimentation pond design.

Sedimentation ponds will be designed to contain and convey flows for all hydrological conditions up to the 100-year flood, with controlled overflow to prevent failure of the containment.

CLOSED-CIRCUIT INDUSTRIAL WATER SYSTEM

Water coming in contact with the industrial area will be recycled and used in the process. This reduces the makeup requirements from the Athabasca River. A closed-circuit industrial water system will be constructed to collect process-affected water within the Pierre River mining areas.

Sources

Sources of industrial (process-affected) runoff water are:

- the plant site, including the ore preparation area
- the external tailings disposal area (ETDA)
- mine pit runoff and drainage

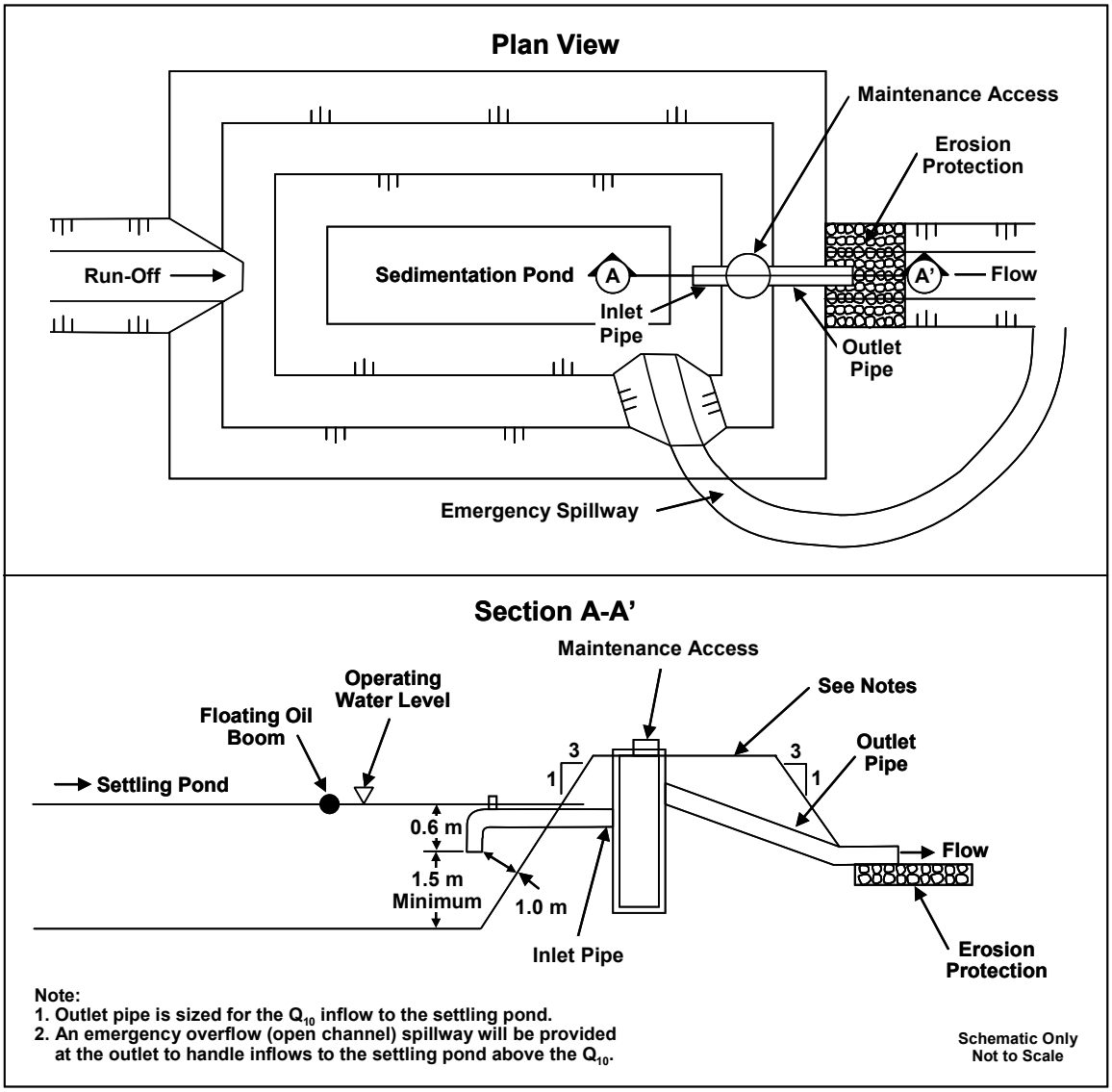


Figure 10-1: Sedimentation Pond Conceptual Design

Plant Site Runoff

Before operations begin, drainage from the plant and ore preparation areas will be collected and routed through the sedimentation pond. During operations, runoff from these sources will be collected within a closed-circuit system and used as process water for bitumen extraction. Runoff from the plant site will be sent to the recycle water pond.

External Tailings Disposal Area Runoff

Runoff from the external surface of the tailings dyke and tailings seepage will be collected in a perimeter ditch and routed to a seepage pond. Water from the seepage pond will be pumped into the ETDA.

Mine Pit Runoff and Drainage

Mine pit drainage will generally be collected in the closed-circuit industrial water system and recycled. However, in some areas where acceptable water quality standards can be attained, runoff could be directed to sedimentation ponds and released to the surrounding muskeg. Details of the conveyance and storage of water in the closed-circuit industrial water recycle system will be similar to those currently used in the existing systems at the Muskeg River Mine.

GROUNDWATER

Sources

Groundwater will be produced from the following sources:

- basal aquifer dewatering
- seepage into the mine pit

Basal Aquifer Depressurization

Depressurization of the basal aquifer is required for safe and efficient mine operations. The location and number of wells will be determined based on observed groundwater levels in the basal aquifer and on operational considerations. Water from the depressurization wells will be conveyed via pipeline to the ETDA.

Seepage into Mine Pit

Water yield from the localized perched water tables is part of seepage from the mine pit walls. Because the yield will be low and sporadic, it has not been included in the estimate of available groundwater. However, it will be collected within the mine and transferred to the ETDA.

PURPOSE

The water management system for the Pierre River Mine will be designed to manage water inventories on site to reduce water withdrawals from the Athabasca River. The system will maximize the use of supplemental water sources and water use efficiency.

WATER MANAGEMENT SCHEMES

The water management schemes that will be used at the Pierre River Mine when tailings are disposed of are shown in:

- Figure 10-2 for the ETDA
- Figure 10-3 for in-pit tailings

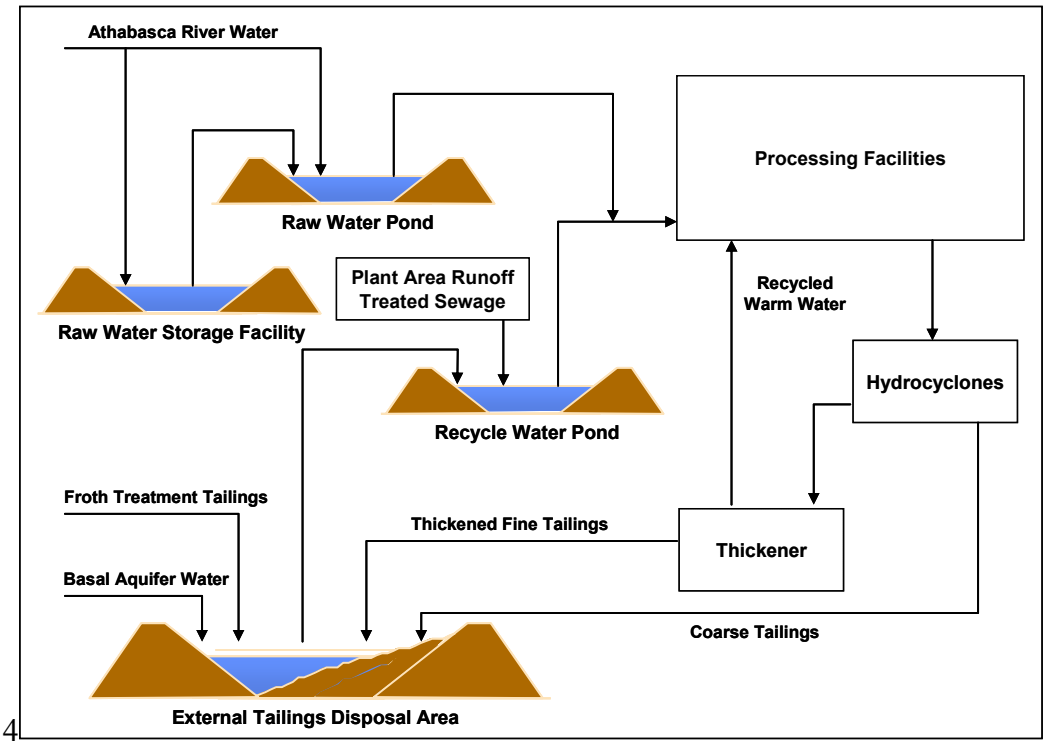


Figure 10-2: Water Management Scheme for the ETDA

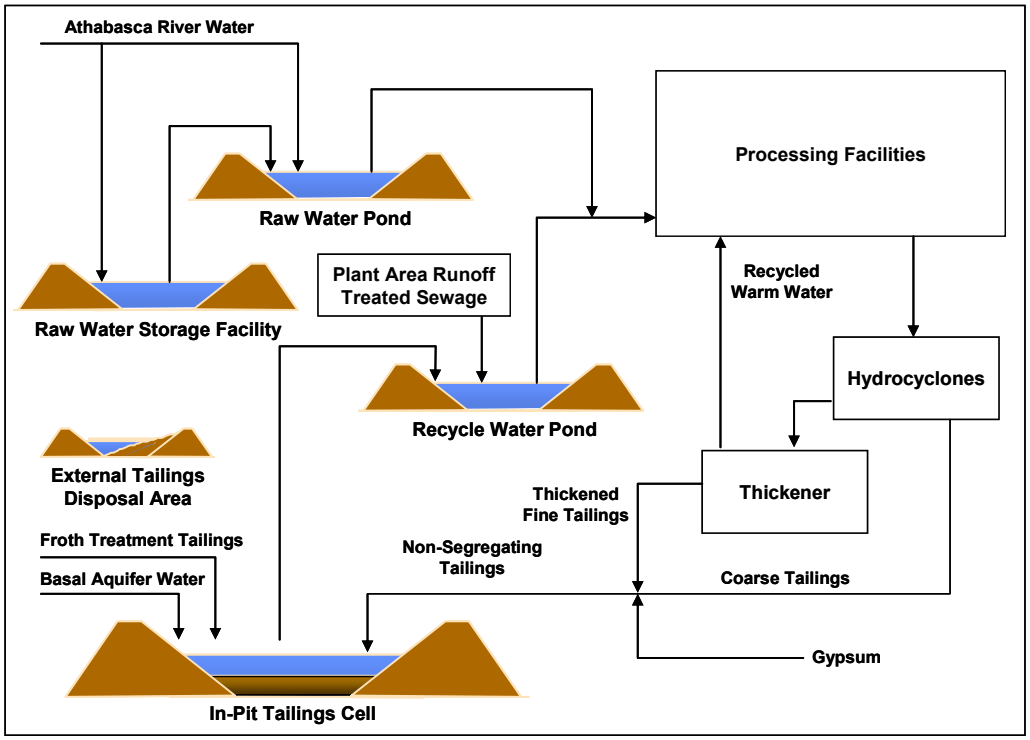


Figure 10-3: Water Management Scheme for In-Pit Tailings

PROCESS WATER

Water Demand

The Pierre River Mine is designed to produce 31,800 m^3/cd of bitumen. The process plant will require an average of about 13,800 m^3/h of water to process the oil sands. On a volume basis, the annual average water required from all sources will be about 35 Mm^3.

Primary Water Source

The Athabasca River will be the source of makeup water for the Pierre River Mine.

The Pierre River Mine will require a new river intake structure north of Sled Island on the Athabasca River. Several locations and styles of intakes were considered, and a conventional bank-style intake was selected (see Section 13, Alternatives Considered). The new intake design will have a capacity of 17,000 m^3/h (4.72 m^3/s) and the maximum annual makeup requirements for the project will not exceed 55.1 Mm^3/a.

For additional information on the water intake system, see Section 8.1, Water Systems.

Athabasca River Water Withdrawal

Shell is committed to managing the water resources in the region responsibly and to continuously improving water use efficiency. Water management practices will be designed to monitor water use carefully, and to identify and evaluate opportunities to reduce the makeup water requirements from the Athabasca River.

The estimated water withdrawal from the Athabasca River for the Pierre River Mine will vary (see Figure 10-4), based on the phase of the development and the amount of available on-site supplemental groundwater and surface water. Surface water contributions will fluctuate with climatic conditions and the size of the closed-circuit runoff area.

Groundwater yields from on-site dewatering are expected to vary as the piezometric surface is lowered and as developments proceed on other leases in the area.

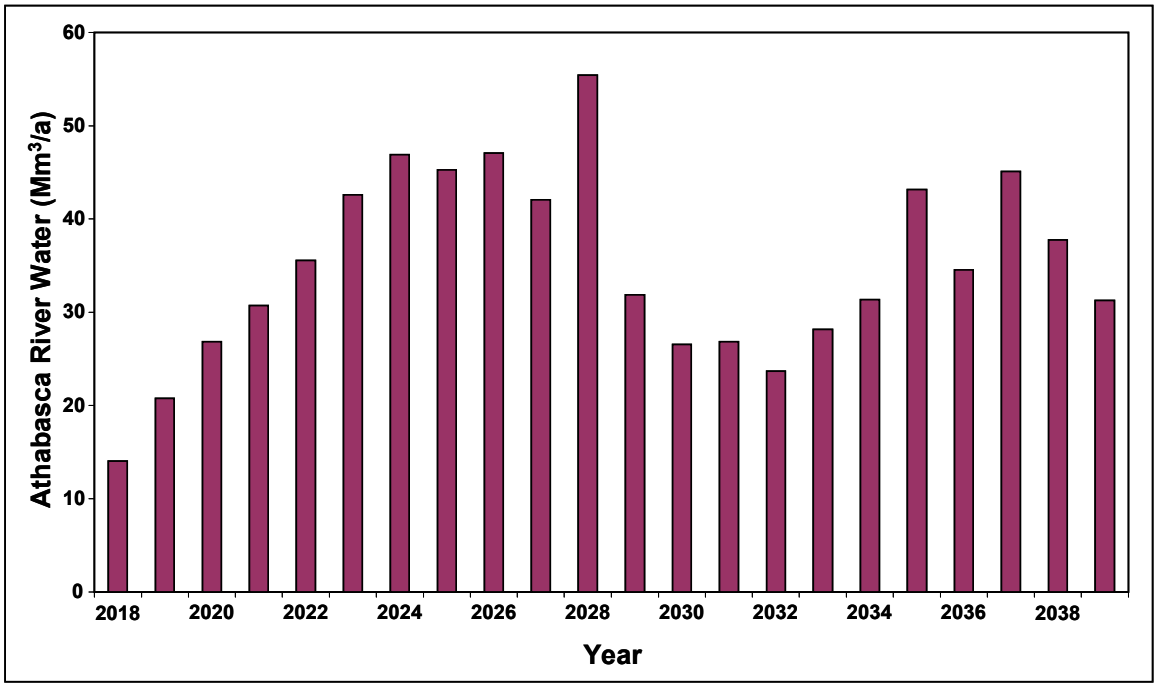


Figure 10-4: Estimated Water Withdrawal from the Athabasca River

The estimated withdrawal is based on the following design assumptions:

- the total annual precipitation is low and no surface water contributes to the water system
- water is lost from constant plant water loss, evaporation losses from raw water, recycle water, the ETDA and consumptive uses
- estimates of groundwater contribution and seepage losses from the ETDA are conservative

Supplemental Water Sources

Supplemental process water will be supplied by:

- runoff and seepage within the closed-circuit system
- the basal aquifer

These on-site water sources are classified as supplemental sources because their:

- flow quantities are temporal and seasonal
- reliability and longevity are based on estimates from predictive modelling

Supplemental water sources will be used for the Pierre River Mine processes, as available, and will be supported by supply from the Athabasca River to the extent that supplemental water sources are not available.

In addition to water supply requirements under the Alberta *Water Act*, as administered through *Water Act* licences, the Pierre River Mine will also comply with the *Water Management Framework for the Lower Athabasca River* (Alberta Environment and Fisheries and Oceans Canada, 2007). If the quantity of water being withdrawn from the Athabasca River is constrained for short periods of time during exceptional low-flow periods, process water requirements will be maintained from water inventory in the external and in-pit tailings ponds, and from a raw water storage facility.

POTABLE WATER

Water from the Athabasca River will be treated in a potable water plant that will include ultrafiltration units and a reverse osmosis system to provide water that meets or exceeds the quality levels recommended in Canadian Drinking Water Quality Guidelines.

The Pierre River Mine site potable water plant will be sized to accommodate the needs of the construction camp, as well as potable water needs of the mine facilities.

For further information, see Section 8, Utilities and Infrastructure.

WATER WITHDRAWAL FOR PIT LAKES

After the Operations Phase is complete, Athabasca River water will be used during closure activities to reduce the time necessary for filling the pit lakes. The total withdrawal for this activity will be maintained within the maximum licence limit.

For further information on pit lakes, see Section 17, EIA Summary.

WATER BALANCE ANALYSIS

The water balance analysis and calculations (see Table 10-2) are based on the annual accumulation being equal to the annual inflow, less the annual outflow on the project area.

The water balance analysis demonstrates that water conservation objectives will be achieved.

BASIS OF ANALYSIS

The water analysis was based on water inflow, outflow and accumulation.

Water Inflow

Water inflow includes:

- makeup water from the Athabasca River
- basal aquifer water
- surface runoff from the disturbed lease area

Water Outflow

Water outflows include:

- evaporation losses from waterbodies and the plant site
- groundwater seepage
- atmospheric losses in the process
- domestic consumption

Water Accumulation

Water accumulates in the pores of:

- rejected ore
- coarse tailings
- fine tailings
- non-segregating tailings

Water Accumulation (cont'd)

Water is also found as:

- free-standing water in external and in-pit waste and tailings disposal areas
- stored water in the water system, ponds and sumps
- water in the end-pit lake

Table 10-2: Summary of Annual Water Balance

Year	Inflows							Outflows						Changes in Storage				
	Athabasca River Water Requirements		Net Connate Water	Basal Aquifer and Pleistocene Channel Water	Seepage from Active Mine Pit Walls	Runoff from Closed-Circuit Area	Total Inflows	Plant Losses	Net Evaporation at Recycle, Raw Water and ETDA Seepage Ponds	Net Evaporation at ETDA	Net Evaporation at In-Pit Tailings Areas	Seepage to Aquifer from ETDA	Total Outflows	ETDA Pore Water Storage	In-pit Pore Water Storage	Free Water Storage at ETDA	Free Water Storage at In-Pit Tailings Areas	Total Change in Storage
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Mm³	M³/s	Mm³	Mm³	Mm³	Mm³	Mm³	Mm³	Mm³	Mm³	Mm³	Mm³	Mm³	Mm³	Mm³	Mm³	Mm³	Mm³
2018	12.16	0.39	0.23	0.32	0.95	3.47	17.13	0.70	0.04	0.58		7.57	8.90	3.26		4.97		8.23
2019	22.70	0.72	0.74	0.32	0.95	1.55	26.26	1.40	0.04	1.05		7.57	10.06	10.99		5.20		16.20
2020	30.58	0.97	2.13	0.32	0.95	1.77	35.74	1.40	0.04	1.05		7.57	10.06	22.25		3.42		25.68
2021	35.51	1.13	2.59	0.32	0.95	1.97	41.35	1.40	0.04	1.05		7.57	10.06	29.38		1.90		31.28
2022	41.35	1.31	2.96	0.32	0.95	2.51	48.09	1.40	0.04	2.30		7.57	11.32	36.30		0.47		36.77
2023	50.30	1.60	4.47	0.32	0.95	2.83	58.86	1.40	0.04	2.30		7.57	11.32	48.05		-0.51		47.54
2024	55.05	1.75	4.59	0.32	0.95	3.05	63.95	1.40	0.04	2.30		7.57	11.32	51.30		1.34		52.64
2025	53.16	1.69	4.28	0.32	0.95	3.54	62.25	1.40	0.04	2.78		7.57	11.80	49.89		0.56		50.45
2026	55.24	1.75	4.55	0.32	0.95	3.81	64.87	1.40	0.04	2.78		7.57	11.80	51.29		1.78		53.07
2027	50.19	1.59	4.53	0.32	0.95	3.99	59.97	1.40	0.04	2.78	0.00	7.57	11.80	42.34	8.76	-2.93	0.00	48.17
2028	63.28	2.01	4.25	0.47	0.95	3.44	72.39	1.40	0.04	2.78	1.78	7.57	13.58	45.51	2.92	10.24	0.14	58.81
2029	38.55	1.22	4.53	0.47	0.95	3.89	48.39	1.40	0.04		1.37		2.82		39.09		6.48	45.58
2030	33.45	1.06	4.66	0.47	0.95	3.85	43.38	1.40	0.04		1.37		2.82		40.27		0.29	40.56
2031	33.75	1.07	4.68	0.47	0.95	3.98	43.83	1.40	0.04		1.71		3.15		40.43		0.25	40.68
2032	30.21	0.96	4.30	0.63	0.95	4.26	40.35	1.40	0.04		1.71		3.15		36.98		0.22	37.20
2033	35.23	1.12	4.88	0.32	0.95	4.43	45.81	1.40	0.04		1.71		3.15		42.33		0.33	42.66
2034	38.70	1.23	4.53	0.32	0.95	4.16	48.66	1.40	0.04		1.71		3.15		45.20		0.31	45.51
2035	52.32	1.66	5.16	0.32	0.95	4.17	62.91	1.40	0.04		3.13		4.57		57.93		0.41	58.34
2036	42.46	1.35	5.49	0.32	0.95	4.20	53.41	1.40	0.04		3.59		5.03		47.83		0.55	48.38
2037	53.78	1.71	5.14	0.32	0.95	4.21	64.38	1.40	0.04		3.95		5.40		54.22		4.77	58.99
2038	45.93	1.46	5.00	0.16	0.95	5.06	57.09	1.40	0.04		2.73		4.18		51.91		1.01	52.92
2039	38.65	1.23	4.62	0.16	0.95	5.75	50.12	1.40	0.04		1.56		3.00		46.59		0.53	47.12

PHYSICAL SETTING

The Pierre River Mine will potentially affect some of the streams discharging to the lower Athabasca River (see Figure 10-5). These streams include:

- Pierre River
- Eymundson Creek
- Asphalt Creek
- Unnamed Creek 1
- Big Creek
- First Creek
- Unnamed Creek 2
- Unnamed Creek 5
- Redclay Creek

These watercourses originate in the eastern slopes of the Birch Mountain and drain east, collecting flows mainly from several tributaries in an upland area and discharging to the Athabasca River through a lowland area. Generally, the upland areas are well drained and steep with a 4 to 8% slope. The lowland areas:

- are flat with an average slope of about 0.7%
- have significant beaver activities
- are poorly drained

The watercourses are incised in the lower reaches with channel valley depths up to about 40 m. The surficial soil in the Pierre River Mine is predominantly glaciofluvial (sandy).

OPERATIONAL DRAINAGE PLANS

Creek Diversions for ETDA Construction

To facilitate the construction of the ETDA, First Creek and Big Creek must be diverted. First Creek flows will be diverted south in 2016 by Ditch B to discharge to Ditch C, as shown in Figure 10-6. Big Creek will be diverted around the northwest corner of the ETDA by Ditch A in 2016 to discharge to a lower reach of the creek.

Creek Diversions for Raw Water Storage Facility

A raw water storage facility will be required by 2018. This facility will be located in a valley adjacent to the Athabasca River Valley, and will be contained and partitioned by five dykes to create two separate waterbodies. The middle dyke will prevent interflow between the two waterbodies, and the northern dyke will prevent Redclay Creek flows to the north waterbody. The south waterbody will be maintained with pumped raw water from the Athabasca River, and the north waterbody will be sustained by Big Creek flows. A diversion system consisting of a dyke and a channel will be required to divert Big Creek flows to the north waterbody. Outflows from the north waterbody will be discharged to the Athabasca River through an outlet channel that will be designed as a closure (geomorphic) channel.

Diversion Ditches

In 2016, the flows in the Pierre River and Unnamed Creek 1 will be diverted south by Ditch H around the Pierre River Mine development area to the Athabasca River. Flows in Eymundson and Asphalt creeks will be diverted north by Ditch C through oil sands Lease 14 to the Athabasca River. Table 10-3 summarizes the information on the operational ditches.

Table 10-3: Pierre River Mine Operational Ditches

Ditch	Construction Year	Length (km)	River or Creek Diversion	Receiving Natural Stream
A	2016	3.3	Big Creek	Big Creek
B	2016	4.5	First Creek	Athabasca River
C	2016	9.5	Eymundson and Asphalt creeks	Athabasca River
Ditch H	2016	6.0	Unnamed Creek 1	Athabasca River

Closure Drainage System

The closure drainage system will convey runoff from the ETDA through a series of swales to a central drainage channel (C1). Channel C1 will be excavated through the north ETDA and an overburden disposal area (OBDA) that will be constructed on the west side of the ETDA during decommissioning. Channel C1 will direct the flow west to the predisturbance topography and into Channel C2, which will follow the northern edge of the ETDA and discharge into the raw water storage facility. The raw water storage facility used during operations will be converted during decommissioning and closure to a treatment lake. The treatment lake will collect ETDA runoff and seepage and will discharge to the Athabasca River through an outlet channel (C3).

Closure channel C4 will be constructed north of the ETDA to collect flows from Big Creek and several smaller unnamed creeks and allow for fish passage from the Athabasca River. This channel will flow northeasterly and discharge into the Redclay Compensation Lake. The Redclay Compensation Lake is proposed as part of the fish compensation for this application. This waterbody will be connected to the Athabasca River through a designed outlet channel (C5).

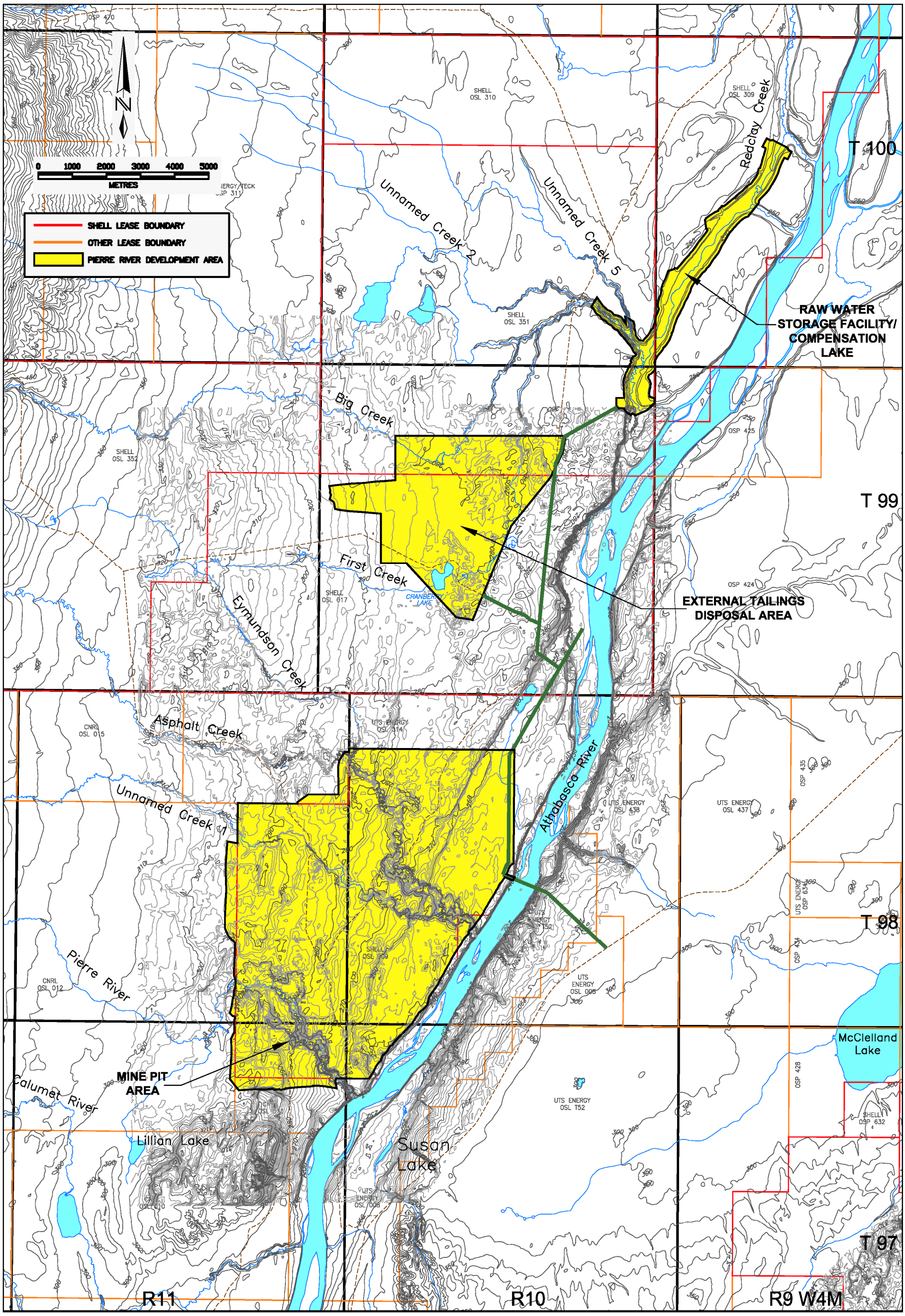


Figure 10-5: Regional Drainage

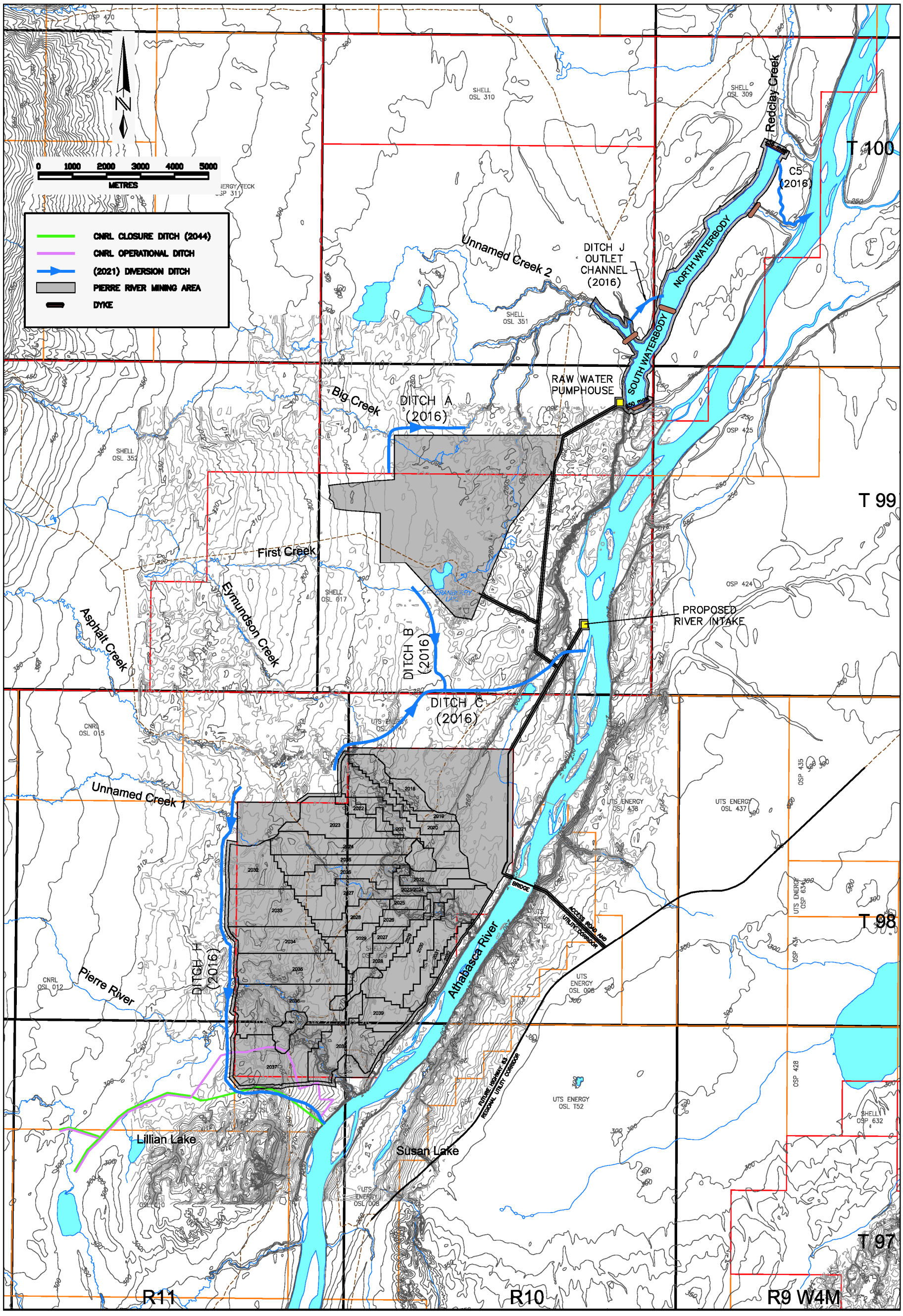


Figure 10-6: Creek Diversion Plan

Pierre River Mine clarification Cell 1 will be converted to the North Pit Lake during decommissioning. Eymundson Creek and Asphalt Creek will be diverted to flow into the Pierre River Mine North Pit Lake through a drainage channel (C6). Unnamed Creek 1 also flows into the Pierre River Mine North Pit Lake. The Pierre River and several small channels will be diverted south around the mining area through channel C11 and discharge to the Athabasca River.

The Pierre River Mine End Cut (Cell 5) will become the Pierre River Mine South Pit Lake during decommissioning. The south containment (Dyke 14) for clarification Cell 2 will be breached above the mature fine tailings (MFT) elevation to join with the South Pit Lake when lake levels reach the ultimate design elevation.

Inflows to the Pierre River Mine North Pit Lake and surface runoff from within the Pierre River Mine will be conveyed to the Pierre River Mine South Pit Lake through channel C7.

The South Pit Lake will be segmented, with a downstream cell free of tailings. The South Pit Lake will discharge from the downstream cell through channel C8 to the Athabasca River.

The closure drainage plan was developed to accomplish the objectives of long-term sustainability and minimal aquatic impacts on receiving streams. The drainage routes were selected and designed to:

- maximize long-term sustainability
- minimize the changes in flows in the surrounding creeks and rivers
- allow for fish migration

APPROVAL REQUESTED

Approval under the *Water Act*, and the associated licence, is requested to cover:

- the delineation of the area boundaries identified in the application to incorporate the Pierre River Mine and its associated facilities
- water withdrawals from the Athabasca River
- the diversion of surface water from the project area
- all activities related to the *Water Act* that will allow the licensee to carry out the activities granted under an EPEA approval

APPLICATION FORM

The application for approval under the *Water Act* is provided in Attachment 10-1.

Attachment 10-1

An Application to Obtain Approval to Divert Water Associated with Operating the Pierre River Mine Areas

Application under the *Water Act* for Approvals and/or Licences

Documents or information provided to Alberta Environment pursuant to section 15(1)(a) of the *Water (Ministerial) Regulation* are public records and are accessible by the public.

Check one or more of the following to indicate type of application:

Diversion of water ☒ Renewal of a licence ☐ Constructing Works ☐

Applicant:

Print Name and Company Name (if applicable):		Home Telephone:	Bus. Telephone:
Shell Canada Limited		( )	**(403) 384-5194**
Address (Street, PO Box, etc.):	**Place, Province:**	**Postal Code:**	**Fax:**
400-4th Avenue S.W.	**Calgary, Alberta**	**T2P 2H5**	**(403) 384-5130**

Are you the registered landowner? Yes ☒ No ☐ If no, please attach a copy of the consent from the landowner.

Consultant, Signing Authority, or Applicant's Representative (if applicable):

Print Name and Company Name (if applicable):		Home Telephone:	Bus. Telephone:
		( )	( )
Address (Street, PO Box, etc.):	**Place, Province:**	**Postal Code:**	**Fax:**
			( )

Contact Person if not shown above:

Print Name:	Telephone:	Fax:
Michael Saretsky	**(403) 384-5194**	**(403) 384-5130**

Project Description:

Tentative Starting Date: 2014 (if applicable)

Duration of Construction/Development: 3 years

Duration of Water Diversion/Use: +25 years

Provide a detailed description including location of works and activities relating to the project and attach plans:

This application is to obtain approval to divert water associated with operating the Pierre River Mining Areas. This application is provided in conjunction with applications to EUB and AENV. Additional information supporting this application is provided in Volume 2, Section 10, Water Management.

Affected Water Sources (Location of Works and Activities):

Surface Water (if only constructing works, complete the first two columns):

Source (e.g. lake, stream, or name of source, if known)	Diversion/Activity Location ¼ sec twp rge m	Annual Quantity (cubic metres)	Rate of Diversion (show units)	Is Construction or Development Required? (Yes or No)	Purpose
1. Athabasca River		55,100,000	4.72 m^3/s	Yes	Industrial processing and domestic use
2. Site Runoff		23,000,000	NA	Yes	Industrial process
3.					

Groundwater:

Date Well Drilled or proposed drilling date	Well (proposed) Locations ¼ sec twp rge m	Total Depth (metres)	Production Interval (metres)	Pumping Rate (show units)	Annual Quantity (cubic metres)	Purpose
1. General Diversion					1,260,000	Industrial Process
2.						
3.						

Please attach a separate sheet if you wish to provide more information.

Statement of Confirmation:

The information given on this form is true to the best of my knowledge.

December 12, 2007		Michael Saretsky	Shell Canada Limited
Date of Signing	Signature	Print Name	Company Name (if applicable)

Return the completed form to an Alberta Environment Regional office nearest you:

Northern Region, Peace River
Bag 900–5 Provincial Building
9621 – 96 Avenue
Peace River, AB T8S 1T4
Telephone **(780) 624-6167**
Fax: (780) 624-6335

Northern Region, Edmonton
Twin Atria
111, 4999 – 98 Avenue
Edmonton, AB T6B 2X3
Telephone: (780) 427-5296
Fax: (780) 427-7824

Spruce Grove
250 Diamond Avenue
Spruce Grove AB T7X 4C7
Telephone: (780) 960-8600
Fax: (780) 960-8605

Central Region, Red Deer
304, Provincial Building
4920 - 51 Street
Red Deer, AB T4N 6K8
Telephone: (403) 340-7052
Fax: (403) 340-5022

Southern Region, Calgary
2938 - 11 Street, NE
Calgary, AB T2E 7L7
Telephone: (403) 297-6582
Fax: (403) 297-2749

2nd Floor, Provincial Building
200 - 5 Avenue, South
Lethbridge, AB T1J 4L1
Telephone: (403) 382-4254
Fax: (403) 381-5337

(call the Regional office for the location of area offices)

OFFICE USE:

File Number:	Fee Receipt Number:	Application ID: Operation ID:
Notice Information:	Application Completion Date:	Priority Number:

SCOPE

The Pierre River Mine will generate waste materials similar to those generated at the Muskeg River Mine. The waste materials will be managed in an environmentally responsible way, including:

- identifying, measuring and controlling waste
- classifying waste
- handling, storing, recycling or disposing of waste
- tracking and reporting waste generated

Waste management activities will be closely monitored to:

- ensure compliance with all applicable corporate standards and provincial regulations

- encourage the most efficient use of resources through the waste management principles of reduce, reuse, recycle and recover, where practical

Waste and waste management facilities will be carefully managed to prevent the unauthorized release of substances to the environment. If a release occurs, it will be handled according to the facility's Emergency Preparedness and Response Plan (see Section 12.4).

PRINCIPLES OF WASTE MANAGEMENT

Minimizing and Recycling Waste

Pierre River Mine development activities will follow the existing Waste Management Plan for the Muskeg River Mine. The objectives of the plan are to:

- minimize the quantities of waste generated, by focusing on:
  - reducing waste at the source
  - controlling inventory
  - implementing purchasing criteria
  - replacing materials with ones that produces less waste or a more benign waste, where practical

Minimizing and Recycling Waste (cont'd)

- recycle spent products or materials into useable materials at the project site or through off-site third-party recyclers and reclaimers, where practical
- provide employee awareness and monitoring programs that include waste minimization and recycling practices

Preventing Pollution

The hierarchy of priorities that will be incorporated into project development activities for preventing pollution is:

1. avoid waste production
2. reduce waste
3. reuse and recycle waste
4. recover energy from waste
5. treat, contain or remediate waste

MAJOR SUBSTANCES USED

Table 11-1 summarizes the major substances to be used at the Pierre River Mine and their classification under the *Canadian Environmental Protection Act* (CEPA). Substances listed under the CEPA include:

- toxic chemicals (Schedule 1)
- priority substances (PSL2)
- substances on the National Pollutant Release Inventory (NPRI)
- Track 1 substances targeted under Environment Canada's toxic substances management policy

Table 11-1: Major Substances to be Used at the Pierre River Mine

Substance [1]	Application	CEPA Substance Classification			TDG
		Schedule 1	NPRI	Track 1	
Processing					
Process solvent	Selective precipitation of asphaltenes	Yes [2]	Yes	No	3
Flocculant	Agglomeration of fine tailings	No	No	No	N/A
Defoamer V-158	Surfactant to break foam in the tailings solvent recovery unit (TSRU)	No	Yes	No	N/A
Phosphate (di-sodium and tri-sodium)	Corrosion inhibitor in sulphur recovery	Yes	No	No	N/A
Potable Water Treatment					
Biocide	Kill algae in raw water	Yes	Yes [3]	No	8
Sodium hypochlorite	Water disinfectant and biocide	Yes	No	No	8 (9.2)
Water Treatment					
Ferric chloride	Promote coagulation of fines	Yes	No	No	8 (9.2)
Sulphuric acid	Maintain optimum pH for coagulation	Yes	Yes	No	8
Sodium hydroxide	Carbon dioxide control in reverse osmosis	Yes	No	No	8
Regeneration brine salt (NaCl)	Regenerate zeolite softener	Yes	No	No	N/A
Boiler Water Treatment					
Amine blend	Buffer for pH control	Yes	No	No	N/A
Asphaltene-Fired Cogeneration Unit [4]					
Flocculant	Agglomeration of fine tailings	No	No	No	N/A
Urea	Air emissions treatment	No	No	No	N/A
Limestone	Air emissions treatment	No	No	No	N/A
Activated carbon	Air emissions treatment	No	No	No	N/A

Note:

1. Any substance to be used by the project that is on the Domestic Substances List and categorized as requiring further assessment under Canada's Chemical Management Plan will be reported in accordance with Schedule 2, Section 71 of the Canada Gazette notice, if thresholds on import, manufacture or use are exceeded, as applicable at that time.
2. Assumes that a typical Canadian product is purchased.
3. As chlorine.
4. Depending on the emission control technology selected during detailed design, the substances used might vary.

SOURCES OF WASTE

Waste will be generated from several sources during the construction and operation of the Pierre River Mine, including:

- the construction camp
- administration offices
- the laboratory
- kitchens in the office building
- the first aid room
- utilities and services, including the asphaltene-fired cogeneration unit
- maintenance shops
- the processing plant

TYPES OF WASTE

Each type of waste will be categorized according to its specific handling and disposal requirements. Four types of waste will be generated by the Pierre River Mine (see Table 11-2).

To reduce its volume, waste will be recycled whenever practical.

Table 11-2: Categories of Waste to be Used at the Pierre River Mine

Waste Type	Category
Non-hazardous solid waste	Class II, non-hazardous combustible waste, and Class III, non-hazardous inert solid waste.
Non-hazardous liquid waste	Class II, non-hazardous liquid waste.
Hazardous solid waste	Class IA and Class IB, waste unsuitable for the Class III landfill.
Hazardous liquid waste	Class IA and Class IB, waste unsuitable for the Class III landfill.

Table 11-3 indicates the expected volume of waste resulting from Pierre River Mine activities, by waste type.

Table 11-3: Pierre River Mine Waste Volumes

Waste Type	Pierre River Mine [1] (t)
Non-hazardous solid waste:	
• flue gas desulphurization solids [2]	350,000
• bottom ash [2]	50,000
• fly ash [2]	185,000
• spent activated carbon [2]	450
• domestic waste	413
• inert waste	2,880
• scrap metal	1,527
• other [3]	1,619
Non-hazardous liquid waste	unknown
Hazardous solid waste	35
Hazardous liquid waste:	
• solvent	51
• waste oil	1,216
• other [4]	4

Note:

1. Annual volumes of waste generated at 31,800 m^3/cd (200,000 bbl/d) production.
2. The annual volumes of waste associated with asphaltene-fired cogeneration.
3. Includes drilling mud, plastics, tires, oil filters, oily rags, grease, paper and cardboard.
4. Includes diesel, glycol, methanol and paint.

Non-Hazardous Solid Waste

Non-hazardous solid waste includes any solid waste that is not reasonably expected to undergo physical, chemical or biological changes to the extent of producing substances that might have adverse environmental effects.

Where practical, recyclable solid waste, including scrap metal, will be diverted from the landfill, and transported to the waste management centre for sorting and processing. The scrap metal yard is capable of supporting the quantities of scrap metal expected to be generated at the Pierre River Mine.

Empty plastic oil pails and jugs collected around the site will be recycled through the Alberta Used Oil Management Association. Any reusable wood or pallets will also be diverted from the landfill and used, where applicable.

Class II waste, such as screened solids from equipment and filter sludge, will be collected and disposed of at an appropriate off-site facility.

Domestic Solid Waste

Domestic solid waste, including kitchen waste from the construction camp and offices, will be collected in bear-proof waste bins located outdoors near the kitchen, canteen, office and living quarters. The waste will be collected by a waste management contractor and hauled to the Fort McMurray Class II municipal landfill for disposal.

In addition to the waste bins, labelled recycle bins will be located in areas where recyclable waste, such as paper, cardboard and beverage containers, will be generated. Paper and cardboard will be compacted and banded at the Pierre River Mine waste management facility and shipped to an approved recycler.

Inert Solid Waste

Inert solid wastes will include clean, uncontaminated solid waste, such as:

- concrete and other building materials from the construction facilities and plant operations
- asphalt
- ceramic materials
- glass
- paper, cardboard and scrap metal, which are recycled
- rubber
- dry timber, wood or discarded lumber that is not treated with toxic wood preservatives
- plastics

Inert solid waste will be disposed of in a Class III landfill located on the Pierre River Mine property. Inert solid wastes will be collected in bulk in bins located outdoors at strategic locations.

Non-Hazardous Liquid Waste

Oily water is an example of a non-hazardous liquid waste. Oily water will be generated in the:

- vehicle fuelling station expansion
- plant maintenance building expansion
- truck shop expansion
- new froth treatment area

Oily water from these areas will be collected from floor wash, runoff and trenches, and routed to local sumps. If the water contains unacceptable levels of free hydrocarbons, it will be directed to an oily water separator. The treated water and water free of hydrocarbons will be pumped to the extraction area emergency

Non-Hazardous Liquid Waste (cont'd)

dump pond. The collected waste oil will be removed and transported off site to appropriate recycle or disposal facilities.

The froth treatment area will be serviced by a closed hydrocarbon drain system. Oily water will be collected and treated in this system.

Hazardous Waste

Class IA and IB waste will be stored in properly designed containers and drums at a secure facility at the mine site. No highly hazardous waste products will be used or generated during construction or operation of the facilities. The stored materials will be removed regularly and transported to an approved off-site disposal centre. The design of the storage facility will comply with the *Guidelines for Storage of Hazardous Material* and will be used to temporarily store Class 1A and 1B waste.

Hazardous Solid Waste

Hazardous solid waste from the Pierre River Mine will be temporarily stored in the hazardous waste storage building before being shipped to an approved recycle or disposal facility.

Hazardous solid waste that will be produced at the Pierre River Mine includes:

- batteries
- fluorescent bulbs
- electronic debris
- aerosol cans

Hazardous Liquid Waste

Hazardous liquid waste from the Pierre River Mine will be stored temporarily in storage tanks with secondary containment or in labelled drums. Hazardous liquid waste will be shipped offsite to a commercial recycling or disposal facility, as applicable to the waste type. Most hazardous liquid waste at the mine, except for acid and alkalis, will be recycled.

Hazardous liquid waste that will be produced at the Pierre River Mine includes:

- waste oil and lubes
- antifreeze
- cleaners
- solvents
- grease
- paint
- laboratory waste

WASTE MANAGEMENT FACILITIES

Waste management facilities will be constructed at the Pierre River Mine to support all construction and operational activities, including:

- an on-site Class III landfill for the disposal of inert solid waste
- a waste management facility
- a wastewater treatment plant

Class III Landfill

A Class III landfill was constructed to accommodate the disposal of about 10,000 t/a of Class III waste expected to be produced at the Pierre River Mine. The landfill will also be the primary disposal area for non-hazardous wastes produced during the construction, operations and closure phases of the Pierre River Mine. All wastes to be disposed of in the landfill will be closely examined before disposal.

Non-hazardous wastes to be disposed of consist of paper, glass, non-pressure-treated wood, cardboard, plastics, filter cake from the sewage plant and other miscellaneous wastes from construction facilities and plant operations. Designated staff will be assigned to ensure compliance with this commitment. All hazardous and domestic waste will be transported off site to be disposed of at an approved location.

The landfill's design capacity of 150,000 m^3 will be sufficient to manage an estimated 30 years of project inert waste generation. The landfill geometry facilitates all-weather access and operation throughout the operating and post-closure period. The landfill design could accommodate a vertical expansion, if additional capacity is required in future.

Waste Management Facility

A waste management facility will be constructed at the Pierre River Mine to support reducing, reusing, recycling and recovering materials. The facility will be a graded, surface-gravelled area of 150 m by 100 m, surrounded by a chain link and barbed wire fence. Laydown areas will be provided for metal, tires and reusable wood (treated and untreated). Ample area will be provided for equipment and spare bin storage. The following structures will be part of the facility:

- a hazardous waste storage building
- a waste transfer station
- a recycling complex
- a scrap metal yard

Hazardous Waste Storage Building

The hazardous waste storage building will comply with AENV's *Hazardous Storage Guidelines*, June 1998, as amended, and the Waste Control Regulation.

Hazardous Waste Storage Building (cont'd)

The pre-fabricated building will have a galvanized steel grate floor with a sump at least large enough to contain the greater of:

- 110% of the largest tank or drum, i.e., 225.5 L
- 100% of the largest tank or drum plus 10% of the aggregate capacity of all other tanks and drums stored in the building

Waste will be accepted into the facility in drums and tracked according to *Industrial Waste Identification and Management Options*, May 1995, as amended.

Waste leaving the hazardous waste storage building will be taken to either an approved and regulated off-site hazardous waste disposal facility or an approved recycler of hazardous recyclables.

Hazardous waste will be stored temporarily and removed monthly, or as needed, so there should not be a large accumulation of waste. However, additional hazardous waste buildings might be acquired and used in the waste management facility, if waste generation rates dictate a need. Hazardous waste will be transferred to off-site treatment or disposal facilities, according to the federal Transportation of Dangerous Goods (TDG) regulation. A licensed hazardous waste management company will be used to move hazardous waste from the site.

Waste Transfer Station

The waste transfer station will be located within the waste management centre. Waste materials will be brought to this location and deposited in labelled bins or drums, depending on the waste type. This area will also contain empty drums and supplies required to responsibly manage waste from the site. This area will be accessible to project personnel 24 hours per day for waste placement.

Recycling Complex

Recyclable items from the Pierre River Mine, such as paper, cardboard, pop cans, batteries and gloves, will be sorted before they are shipped to an off-site recycler.

Scrap Metal Yard

The scrap metal yard will be located within the waste management centre and will be used to sort scrap metals for recycling.

Wastewater Treatment Plant

A domestic wastewater treatment plant will be designed and constructed at the Pierre River Mine to treat the domestic sewage during construction (for about 2,650 people) and during operations and closure (for 970 people). The estimated domestic wastewater generated from the construction camp is 750 m^3/d, which will reduce to 150 m^3/d during operations.

The wastewater system will include:

- piping
- lift stations
- a treatment plant
- a sludge press

Domestic wastewater collected from the various plant buildings, installations and the construction camp will be delivered to the wastewater treatment plant by local lift stations through a buried pipeline specially designed and constructed for domestic wastewater collection. The treated effluent will be piped by underground forced main to the recycle water pond. Dry sludge from the sludge press will be hauled to a landfill for disposal.

WASTE DISPOSAL

Table 11-4 summarizes the categories of waste expected to be generated during the construction and operations of the Pierre River Mine. The table also identifies the storage and disposal method for each waste category.

Table 11-4: Pierre River Mine Waste and Disposal Methods

Waste Description	Waste Category	Storage Location	Disposal Method or Location
Liquid			
Amine	268	N/A	Recycle water pond
Aluminum sulphate	113	Labelled drums	Approved off-site disposal facility
Boiler blowdown water	136	N/A	Recycle water pond
Cooling tower system blowdown	136	N/A	Recycle water pond
Equipment wash	254	N/A	Recycle water pond
Filter backwash	N/A	N/A	Recycle water pond
Flammable liquids	271	Labelled drums	Approved off-site recycle facility
Flammable liquids	211/212	Labelled drums	Approved off-site recycler
Floor wash	254	N/A	Extraction dump pond
Glycol	222	Above-ground tank	Reuse as spray on ore conveyor belts
Kerosene	221	Labelled drums	Approved off-site recycler
Laboratory waste – hazardous solids and liquids	263	Labelled drums	Approved off-site recycler or disposal
Laboratory waste – non-hazardous solids	N/A	Bin	On-site landfill
Methanol	212	Labelled drums	Approved off-site recycler
Oily water	N/A	Sumps	Tailings pond
Paint-related material	145	Labelled drums	Approved off-site recycle facility
Potassium hydroxide	121	Labelled drums	Approved off-site disposal facility
Sanitary sewage	N/A	Collection system and treatment plant	Sanitary sewage plant, treated sewage to recycle water pond
Spent acids, acid solutions and washings	114	Labelled drums	Approved off-site disposal facility
Spent caustics, alkali solutions and washings	122	Labelled drums	Approved off-site disposal facility
Spent solvents and solvent residues	211	Labelled drums	Approved off-site recycler
Steam condensate	N/A	N/A	Approved off-site disposal facility
Surface runoff water – clean	N/A	Industrial runoff collection ditch	Recycle water pond
Surface runoff water – potentially oily	N/A	Industrial runoff collection ditch	Recycle water pond
Transformer oil	N/A	Labelled drums	Approved off-site recycler
Vent or flare liquids	N/A	Flare knockout drum	Returned to process
Vessel drains	N/A	Sumps	Returned to process or recycle water pond
Waste oils (lubricating, hydraulic, transmission)	252	Labelled drums, tank	Approved off-site recycler
Waste paint and paint-related materials	223	Labelled drums	Approved off-site recycler

Table 11-4: Pierre River Mine Waste and Disposal Methods (cont'd)

Waste Description	Waste Category	Storage Location	Disposal Method or Location
Liquid (cont'd)			
Water contaminated with hydrocarbons	254	Labelled drums	Approved off-site recycler
Water treatment wastewater	N/A	N/A	Recycle water pond
Solid			
Asphaltene-fired boiler and cogeneration bottom ash	146	Silo	ETDA
Asphaltene-fired boiler and cogeneration fly ash	146	Silo	ETDA
Asphaltene-fired boiler and cogeneration gypsum	132	Silo	ETDA
Asphaltene-fired cogeneration spent activated carbon	261	Labelled drums	Off-site approved landfill
Asphaltene-fired boiler and cogeneration spent catalyst	153	Original package	Returned to manufacturer
Bar screenings	N/A	Vacuum truck	Fort McMurray sewage lagoon
Batteries	151	Labelled drums or bins	Approved off-site recycler
Beverage containers	N/A	Recycle bin	Approved off-site recycler
Carbon filters (natural gas)	261	Filter housings	On-site landfill
Cardboard	N/A	Recycle bin	Recycled
Cartridge filters	256	Bin	On-site landfill
Construction material, wood, glass, other debris	275	Bin	Recycled or sent to on-site landfill
Contaminated debris and soil	138/275	Labelled drums or bins	Approved off-site disposal facility
Corrosive solids	N/A	Labelled drums or bins	Approved off-site disposal facility
Desiccant (air dryers)	154	Bin	On-site landfill
Domestic garbage (food remnants and food-contaminated waste)	N/A	Bin	Off-site Class II landfill
Drilling muds	272	Bin	On-site waste dump
Empty calibration gas and compressed gas cylinders	331	Labelled drums or bins	Approved off-site recycler
Empty packages, drums, bags, containers	152	Bins, drums or pails	Returned to supplier, reused or sent to on-site landfill
Empty, pressurized aerosol cans	145	Labelled drums or bins	Approved off-site recycler
e-waste	N/A	Labelled drums or bins	Approved off-site recycler
Filtered sewage cake	274	Vacuum truck	Regional Municipality of Wood Buffalo sewage lagoon
Fluorescent lamps	153	Cardboard box	Approved off-site recycler

Table 11-4: Pierre River Mine Waste and Disposal Methods (cont'd)

Waste Description	Waste Category	Storage Location	Disposal Method or Location
Solid (cont'd)			
Ion exchange resin (softeners)	136	Labelled drums	Approved off-site disposal facility
Kitchen grease	N/A	Grease bin	Approved off-site disposal facility
Oil filters from internal combustion engines	275	Labelled bins	Approved off-site recycler
Oily rags, sorbent pads and materials	274	Labelled drums or bins	Approved off-site disposal facility or recycler
Paper	B3020	Recycle bin	Recycled
Peroxide	N/A	Labelled drums or bins	Approved off-site disposal facility
Plastics, used	N/A	Recycle bin	Approved off-site recycler
Poison	N/A	Labelled drums or bins	Approved off-site disposal facility
Scrap metal	N/A	Recycle bin	Approved off-site recycler
Sock filters	256	Bin	Approved off-site recycler or disposal facility
Spent batteries (acid, alkali, nickel-cadmium, lithium)	1151	Labelled drums, containers	Approved off-site recycler
Tires	N/A	Tire cage	Approved off-site recycler
Toner cartridges for copiers and printers	N/A	Original package	Returned to supplier for recycle
Waste inorganic chemicals, including laboratory packs	148	Labelled drums	Approved off-site disposal facility
Waste organic chemicals, including laboratory packs	263	Labelled drums	Approved off-site disposal facility
Sludge			
Truck wash sump	150	Drums and vacuum truck	Tailings pond
Heat exchanger bundle cleaning	251	Labelled container	Tailings pond
Oil and water separator	251	Labelled drums	Approved off-site disposal facility
Other			
First aid room waste	N/A	Marked hazardous biowaste containers	Regional health centre treatment facility

MANAGEMENT COMMITMENT

Shell believes that managing health, safety and the environment (HSE) is integral to its operations. This requires commitment and leadership from management to communicate the importance of HSE performance and to ensure that plans and resources are provided to achieve HSE objectives. All employees and contractors must understand the HSE objectives and their individual responsibility to help achieve them.

HEALTH, SAFETY AND ENVIRONMENT POLICY

The commitment to HSE management is based on Shell Canada's health, safety and environment policy (see Figure 12-1).

HSE IMPLEMENTATION

For the Pierre River Mine, the HSE policy will be applied by:

- developing and implementing plans to ensure that work is done in an orderly manner that meets Shell's expectations, commitments and values
- providing the required organization and resources to ensure that operational plans are carried out
- providing leadership and accountability, at all levels, for achieving HSE goals
- managing hazards and effects, including systematically identifying significant risks and developing plans to manage them
- implementing procedures and practices to control potentially hazardous tasks
- conducting training and competency assessments to ensure that workers are capable of performing their work safely and efficiently
- monitoring and measuring performance to provide feedback against HSE objectives and performance standards
- taking preventive and corrective action to apply lessons learned on the project and seek continuous improvement
- communicating with stakeholders to identify and understand their concerns, and to foster their involvement

HSE CONTINUOUS IMPROVEMENT INITIATIVES

Adaptive management and continuous improvement in HSE performance will be achieved by:

- implementing an environmental management system that meets the requirements of the International Organization for Standardization (ISO)
- applying self-imposed standards and guidelines
- communicating with stakeholders, including governments and communities, to understand and respond to evolving expectations
- conducting ongoing research to improve the project's efficiency and HSE performance
- continuing to integrate HSE management into business decision making

SUSTAINABLE DEVELOPMENT COMMITMENT

Sustainable development means conducting development in a way that ensures that the use of resources and the environment today does not impair prospects for their use by future generations.

The commitment to sustainable development is set out in Figure 12-1, which integrates economic, environmental and social considerations in decision making. In addition to complying with legislation and exercising environmental due diligence, Shell will continue to improve the overall environmental performance of its operations and products, while ensuring short- and long-term commercial success. Measurable targets will be set, and progress will be assessed regularly.

Sustainable development will be managed by integrating environmental protection into existing management systems throughout all phases of the project.

Commitment to Sustainable Development

Shell Canada is committed to contribute to sustainable development. To our company, this means the integration of economic, environmental and social considerations in the decision-making process across all of our business activities. It means addressing both short-term and long-term needs.

Commitment to Sustainable Development

Our activities are guided by the following principles:

Generate robust profitability

Successful financial performance is essential to our sustainable future and contributes to the prosperity of society.

Deliver value to our customers

Customers are the lifeblood of our business. We seek constantly to strengthen existing customer relationships and develop new ones.

Protect the environment

The natural environment supports all human activity. We continually look for new ways to reduce the environmental impact of our operations, products and services throughout their life.

Manage resources

Efficient use of natural resources, for example, energy, land and water, reduces our costs and respects the needs of future generations. We constantly look for ways to minimize their use.

Respect and safeguard people

We aim to treat everyone with respect. We strive to protect people from harm from our products and operations.

Benefit communities

Wherever we work we are part of a local community. We will constantly look for appropriate ways to contribute to the general well being of the community and the broader societies who grant our license to operate.

Work with stakeholders

We affect, and are affected by, many different groups of people, our stakeholders. We aim to recognize their interest in our business and to listen and respond to them.

Health, Safety and Environment Policy

Shell Canada is committed to:

- pursue the goal of no harm to people.
- protect the environment and pursue the goal of prevention of pollution.
- use material and energy efficiently to provide our products and services.
- develop energy resources, products and services consistent with these aims.
- publicly report on our performance and engage in stakeholder consultation.
- play a leading role in promoting best practice in our industry.
- manage health, safety and environment as any other critical business activity.
- promote a culture in which all Shell employees share this commitment.

Shell Canada Limited:

- has a systematic approach to health, safety and environmental management designed to ensure compliance with the law and to achieve continuous performance improvement.
- sets targets for improvement and measures, appraises and reports performance.
- requires contractors to manage in accordance with this policy.
- requires joint ventures under its operational control to apply this policy and uses its influence to promote this policy in its other ventures.
- includes health, safety and environmental performance in the appraisal of all staff and rewards accordingly.

We strive to achieve a health, safety and environmental performance that we are proud of, to earn the confidence of customers, shareholders and society at large, to be a good neighbour and to contribute to sustainable development.

W. A. Loader
President

August 1, 2003

Figure 12-1: HSE Policy Statement

PURPOSE

The existing Muskeg River Mine HSE management system will serve as the basis for the Pierre River Mine. Ongoing monitoring and continuous improvement of this system will provide an effective basis for adaptive management and self-regulation.

CORE COMPONENTS

Core components of the HSE management system that will be implemented at the Pierre River Mine will include:

- planning
- implementing and operating
- checking and taking corrective action

Planning

Planning includes developing:

- procedures to identify existing and emerging HSE risks and aspects that must be controlled and influenced
- procedures to identify and access legal and other requirements related to HSE
- procedures to establish and maintain documented HSE objectives and targets
- management programs that designate responsibility for achieving HSE objectives and targets

Implementing and Operating

Implementing and operating the system include:

- defining and documenting roles, responsibilities and authorities required for effective HSE management
- providing appropriate awareness and competency training for personnel whose work could create an HSE impact on personnel and project activities

Implementing and Operating (cont'd)

- developing procedures:
  - for internal and external communications
  - to identify the potential for, and the response to, incidents and emergencies, to prevent or reduce the associated effects
- developing documentation of the core elements of the management system
- developing document control procedures to ensure that HSE management system-related documents:
  - can be located
  - are periodically reviewed, revised as necessary, and approved
- developing documented operating procedures for the operations and activities that have significant HSE aspects, as determined by hazard and risk assessments

Checking and Taking Corrective Action

Checking and taking corrective action include:

- developing procedures for:
  - regularly monitoring, measuring and recording key characteristics of operations and activities that can have a significant impact
  - changing operations if monitoring indicates unpredicted effects from the project
  - defining responsibilities and authorities for handling and investigating nonconformance, and carrying out corrective and preventive actions
  - handling and maintaining records, such as those related to training and the results of audits and reviews
- developing a program and procedures for conducting periodic audits of the HSE management system

MANAGEMENT REVIEW

At intervals determined by senior management, but at least annually, the HSE management system will be reviewed to ensure its continuing suitability, adequacy and effectiveness.

INDIVIDUAL COMPETENCY

The ability to implement and maintain management systems depends greatly on the competency of each employee. Therefore, defining HSE critical competency requirements for key work positions and identifying training needs are primary components of HSE management. The following describes the competency and training program in place at the Muskeg River Mine, which will be applied to the Pierre River Mine.

Program Objectives

Objectives of the individual competency program are to:

- ensure that all employees and contractors at the project site are capable of applying the knowledge they receive through training to do their jobs in a manner consistent with the HSE policy and sustainable development commitment statements
- develop competency profiles for key project positions, with a priority on those positions that are HSE critical
- support training requirements by continuously assessing competency
- track training and competency levels for workers

Program Scope

Competency will be maintained by:

- assessing the skills required for each work position
- selecting candidates who meet, or exceed, the minimum skill set for the work positions
- orienting new or transferred personnel into the operation
- evaluating HSE critical skills and competencies continuously, and providing refresher courses or advanced training, where required

Team leaders will be responsible for identifying, monitoring and supporting staff training.

FIELD CONSTRUCTION AND OPERATING TEAM HSE TRAINING

Team members will receive training relevant to their work positions for implementing the HSE plans. This will include training in:

- using and interpreting the hazards and effects management process (HEMP), including hazard and risk assessments

FIELD CONSTRUCTION AND OPERATING TEAM HSE TRAINING (cont'd)

- following incident management procedures and processes for responding to specific incidents
- conducting regular emergency response drills using identified hazards as potential scenarios, followed by an evaluation of the response drill
- applying the incident command system
- following a proactive management process to identify new risks that might result, and ensuring that these potential risks are managed

SCOPE

As a part of the HSE management system, an emergency preparedness and response program for significant site hazards will be developed and maintained for the Pierre River Mine. Emergency response plans, resources and trained personnel will be in place to execute responses appropriate to potential emergency scenarios. The plans will provide structure and guidance for responding to such incidents as:

- spills
- fires
- loss of containment
- injuries

INCIDENT COMMAND SYSTEM

The construction emergency response management system will be modelled on the incident command system (ICS), which is part of the existing emergency response plan for the Muskeg River Mine. The ICS is an organizational system for achieving an effective and orderly response to an incident. If an incident occurs on the construction site, an incident commander will immediately assume overall responsibility for coordinating the response.

The ICS is designed to work for small incidents where a single individual can oversee the entire operation, and for larger, more complex incidents where several trained specialists are required to form the emergency response team. The value of this approach is that it incorporates emergency response roles and a management process that is used internationally and is constantly upgraded with lessons learned from similar situations.

HAZARD AND RISK ASSESSMENTS

A register of hazards and associated risks will be developed for the Pierre River Mine. Controls will be identified for each hazard, to ensure that the associated risks are managed to a level that is as low as reasonably practicable (ALARP). In turn, the hazards and risk registry will determine the specific emergency response plan that will be required for the Pierre River Mine.

EMERGENCY RESPONSE PLAN

A specific emergency response plan for construction will be developed before construction of the Pierre River Mine Project starts. The plan will be continuously updated throughout construction of the Pierre River Mine. The existing Jackpine Mine – Phase 1 emergency response plan will be updated and modified to accommodate new construction activities, commissioning and start-up for the Pierre River Mine.

During the construction phase, the emergency response plan will focus on construction activities. As the project progresses, the plan will focus on commissioning, start-up and operating the new equipment. The emergency response plan for both construction and operations will include:

- protecting the safety of workers and the public
- attending to the injured
- assessing the incident and the resources required to contain or control the emergency
- restoring containment and control
- investigating an incident to identify and analyze the root cause to help prevent a similar incident from occurring
- providing notices and reports according to corporate and regulatory requirements

The emergency response plan for both construction and operations will also include:

- emergency response policies and procedures
- an emergency contact list
- containment and control strategies
- maps
- equipment lists
- information on specialized training needs
- pre-incident plans

EMERGENCY RESPONSE RESOURCES

Resources for responding to incidents include:

- an on-site emergency response team
- on-site emergency facilities and equipment
- off-site emergency resources

On-Site Emergency Response Team

To facilitate an immediate response to an emergency, the construction organization will include an on-site response team. Team members will be trained in:

- firefighting
- spill control and cleanup
- rescue
- first aid

Responsibilities will be defined to ensure that the appropriate personnel will be involved in the response for each incident. If the incident creates a threat to the environment or a variance from environmental permits or regulations, environmental personnel will be involved in determining:

- potential effects from the incident
- control measures to be used
- the required remediation
- specific reporting requirements

On-Site Emergency Facilities and Equipment

Emergency Facilities

An emergency response facility will be provided on the construction site. This facility will include:

- an emergency clinic
- a covered bay for a fire truck
- a covered bay for an ambulance
- supporting offices for emergency response personnel
- fire apparel storage

Spill Cleanup Materials

An inventory of spill cleanup materials will be maintained. Cleanup supply stations with appropriate cleanup materials, including absorbents, will be strategically located throughout the site to support a quick response to spills. Spill cleanup supply stations will be clearly marked and on-site personnel will be trained to use the supplies effectively.

Off-Site Emergency Resources

The site-specific emergency response resources will be backed up by Shell's corporate emergency response system and resources. The project team will also participate in coordinated emergency response services, leveraging from agreements in place at the Muskeg River Mine. These service arrangements include:

Off-Site Emergency Resources (cont'd)

- the Area Y Oil Spill Cooperative, involving:
  - oil sands operators
  - pipeline organizations
  - the Regional Municipality of Wood Buffalo (RMWB)
- mutual-aid agreements with Syncrude Canada Ltd., Suncor Energy Inc. and the RMWB to provide equipment and operators for emergencies
- an agreement to provide funding for, and staff participation on, the RMWB disaster services committee

LEVELS OF EMERGENCY

The decision to request off-site resources will depend on the actual and potential severity of an incident. Emergencies are classified into three tiers (levels), according to the response required and the need for off-site resources:

- A Tier 1 emergency is a local isolated emergency that can be handled by on-site personnel and equipment available at the time of the incident.
- A Tier 2 emergency is a local emergency with the potential for off-site migration. It requires notifying the project's head office-based crisis management team.
- A Tier 3 emergency is an emergency of a magnitude that exceeds the on-site emergency response capabilities and that requires additional resources. The crisis management team and the crisis command centre are activated to provide strategic support and resource allocation. Assistance from other off-site resources might be accessed under mutual-aid agreements.

An assessment of the potential and actual HSE effects of an incident will be an integral part of the initial response. Within the limits of safe operations, the first responders will implement immediate steps to limit the scale of the emergency and to identify the resources required for containment and recovery. Individual competency training and clear accountabilities, coupled with emergency response plans, will provide the framework for a quick and appropriate response to prevent, contain and limit adverse effects.

PREMISE

Diligence will be exercised in designing, constructing, operating and maintaining the facilities to prevent or minimize, to ALARP, the potential for releases of substances that might adversely affect health, safety or the environment. If spills or emissions occur, they will be reported according to the corporate standards and regulatory requirements that apply.

OFF-SITE CONTACTS

For incidents that have, or are likely to have, an off-site impact, appropriate notification will be given to key community, government and industrial contacts. Notification decisions will be based on potential effects and the information available.

CONTENT OF NOTIFICATION

Notifications regarding potential spills and emissions will:

- describe the incident based on the facts available
- identify potential effects
- provide the status of containment and cleanup, as applicable
- identify the incident command team member responsible for providing further updates

CLIMATE CHANGE INITIATIVES

Shell shares the global concern about climate change, and is taking action through:

- focusing on increasing energy efficiency
- developing technology to reduce CO_2 emissions, such as:
    - carbon capture
    - boosting the growth of renewable energy
- working cooperatively with governments

PRINCIPLES

Shell's principles are to:

- meet regulatory emission requirements as a minimum for all new businesses and growth activities
- address direct emissions from facilities under its operational control
- include the cost of carbon in the evaluation of all significant growth projects
- seek continuous improvement opportunities throughout its existing operations and in the design of its new facilities

GREENHOUSE GAS MANAGEMENT PLAN

Shell strives to be a leader in mitigating greenhouse gas emissions, and is exploring viable technological solutions for reducing energy intensity and greenhouse gas emissions resulting from its oil sands mining operations. Shell's main focus for continuously improving the management of greenhouse gases from the Pierre River Mine will be on discrete activities within its control. This includes energy efficient technologies, CO_2 capture and sequestration, and implementing renewable energy options as sources of power or carbon offset.

GREENHOUSE GAS MANAGEMENT PLAN (cont'd)

Shell is committed to using leading commercially viable technologies, operating practices, training and continuous improvement to reduce greenhouse gas emissions from the Pierre River Mine. Initiatives include:

- incorporating lessons learned from the design of the Muskeg River Mine
- evaluating renewable energy options for meeting electricity and process heat demands
- optimizing and continuously improving energy efficiency in the design and operation of processes and facilities, through such measures as:
    - assessing and documenting comparisons of the energy, utility and greenhouse gas footprint of alternative technologies in the design of facilities
    - striving to improve solvent recovery rates
    - providing high-efficiency process heaters, where warranted by size and economic considerations
    - using heat-integration modelling to optimize plant configurations and energy use
    - installing heat exchangers to recover energy from hot process streams, where warranted by economic considerations
- applying best practices to minimize fuel use in haul vehicles, including regular maintenance and computerized mine fleet dispatch

During operations, the Pierre River Mine will set continuous improvement targets for energy efficiency and greenhouse gas emissions as part of the business planning cycle.

PURPOSE

During preparation of this regulatory application, alternatives for the following aspects of project development were evaluated to determine the proposed application basis:

- site conditions, facility and infrastructure locations
- process elements and methods, including mining activities

EVALUATION METHOD

A modified version of the Kepner Tregoe decision-making process was used to:

- identify a full range of alternatives
- compare and evaluate the alternatives
- validate the decision-making process
- help make recommendations for the preferred alternative

This evaluation approach was intended to:

- provide the necessary information, analysis and documentation to enhance long-term planning

- apply a consistent decision-making process that reflected a reasonable balance of environmental, social, regulatory, technical, operational and economic criteria

- ensure that appropriate stakeholders were involved in the alternative selection process for specific areas

The evaluation process enabled aspects of each decision to be documented, presented for input by appropriate stakeholders, and objectively evaluated with consideration given to all input, while ensuring that the evaluation method was consistent.

TOPICS FOR STUDY

Project personnel identified and characterized site conditions, facility and infrastructure locations and process methods that could be considered as alternatives for the Pierre River Mine.

Site Conditions and Facility and Infrastructure Locations

The site conditions and facility and infrastructure location alternatives that were considered included:

- ore criteria, such as cut-off grade, TV/BIP and mining thickness
- the extraction and mine facility location
- orebody optimization
- overburden and reclamation material stockpiles (RMS)
- external tailings disposal location
- a crusher location
- stream diversions
- a water storage facility type and location
- an access road location
- a plant site location
- storage tanks for solvent and diluted bitumen
- a cogeneration plant location
- a location for utility corridors
- locations for gravel sources
- a froth treatment location

Process Methods

The following process methods were identified as having possible alternatives:

- the mining method, including equipment
- tailings management
- ore preparation
- ore conditioning and extraction
- primary bitumen extraction
- froth treatment
- process water sourcing
- basal aquifer disposal
- electrical power and heat (thermal) supply
- waste handling

HIERARCHY OF REVIEW

The alternative site conditions and facility and infrastructure locations were reviewed in the following order:

1. orebody optimization

2. ore criteria
3. mine opening and sequence
4. external tailings disposal location
5. plant site
6. access roads

Each topic for study was discussed to verify that possible alternatives existed. If alternatives were not viable, the topic was eliminated from further review. Section 13.2 describes some of the topics that were eliminated.

ALTERNATIVES REVIEWED

Alternatives for the following were evaluated in detail:

- an external tailings disposal location (see Section 13.3)
- stream diversions (see Section 13.4)
- access roads and bridge crossing (see Section 13.5)
- cogeneration – power and steam generation (see Section 13.6)
- river water intake location (see Section 13.7)
- river water intake design (see Section 13.8)
- project timing (see Section 13.9)

ALTERNATIVE STEERING TEAM

An alternative steering team (AST), comprising senior staff and project specialists, appointed team leaders for the various topics. The team leaders then assembled selection teams made up of specialists from the project with appropriate expertise in the environmental, social, regulatory, technical, operational and economics fields.

The selection teams' role was to analyze the alternatives for their study topics and to present the preferred alternative to the AST.

Key stakeholder input was requested during the study of alternatives for:

- stream diversions
- access routes

This input was received through a series of meetings that allowed for alternatives, criteria and scoring to be presented to the stakeholders for their input and comments.

The steering team's role was to approve which alternative case would be put forward as the Application Case and which would be considered for further study. The AST ensured that stakeholder input had been considered, and that any potential biases that might have occurred from the analytical method were eliminated.

ALTERNATIVES SELECTION PROCESS

Once possible alternatives were identified, criteria were developed by the selection teams to enable the various alternatives to be compared (see Figure 13-1).

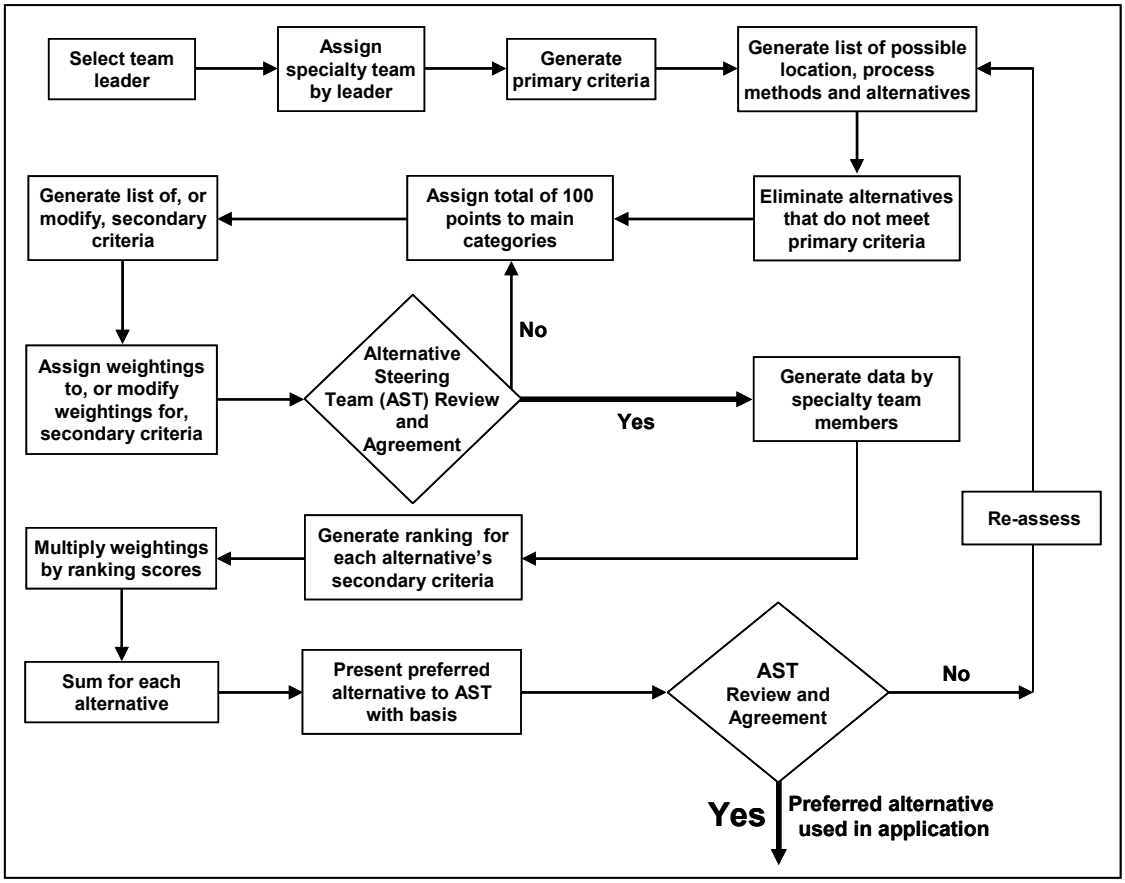


Figure 13-1: Alternatives Selection Process

The criteria were separated into:

- primary criteria
- secondary criteria

If an alternative could not meet the primary criteria requirement, it was eliminated from further study.

Alternatives that did meet the primary criteria were compared and ranked, using the secondary criteria. These secondary criteria were divided into the following three general categories, which were common to all of the evaluation studies:

- economics
- technical and operations
- environmental, social and regulatory

The selection team assigned weighting factors to all of the criteria. Consensus was reached by all team members before the weighting factors were assigned.

The selection team then ranked the alternatives for each secondary criterion, using any facility-specific or process-specific information compiled by the various specialists. For example, the lowest ranking (1) was the least preferred and the highest (5) was the most preferred.

The justification for the relative ranking of each secondary criterion was documented and the total score for each alternative was calculated by multiplying the weighting by the rank.

The alternative with the highest score was the one most likely to be presented as the preferred alternative in the study.

SCOPE

The following site conditions, facility and infrastructure locations, and processes that were identified in the preliminary meeting did not go through a further detailed alternative review because of physical, environmental or conceptual constraints:

- ore criteria
- orebody optimization
- extraction plant and mine location
- overburden and reclamation material stockpile locations
- crusher location
- gravel sources
- basal aquifer disposal
- waste handling

This subsection outlines the rationale for excluding these conditions, locations and processes from a detailed evaluation.

ORE CRITERIA

The EUB guidelines provide the following criteria for mining oil sands:

- a cut-off grade of 7 wt% bitumen
- a minimum mining thickness of 3 m
- a cut-off total volume to bitumen-in-place (TV/BIP) ratio of 12 or lower

These criteria were applied during the development of the initial mine plan at the Pierre River Mine. As the project progresses, these criteria might be modified during subsequent mine optimization to reduce or improve recovery. For further information on ore criteria, see Section 5.2, Mine Plan Limits.

OREBODY OPTIMIZATION

Mining an orebody is an iterative process defined or bounded by three limitations:

- physical constraints

OREBODY OPTIMIZATION (cont'd)

- economical ore mining limits
- lease boundary assumptions

Satisfying these limits and working within the constraints and assumptions effectively eliminated alternatives to study. Section 5.4, Mine Planning Criteria, and Section 5.5, Mine Development Plan.

EXTRACTION PLANT AND MINE LOCATION

The current, estimated mineable oil sands ore at the Pierre River Mine is located primarily on oil sands Lease 9, which is bounded on three sides by the physical constraints of other oil sands leases, and by the Athabasca River on the fourth side. Only the northeast and the northwest portions of Lease 9 did not meet the EUB criteria for mineable oil sands ore. To optimize haul distances and minimize disturbance, the extraction facility, overburden dumps and reclamation material stockpiles (RMS) were positioned at the northern portion of the lease where the TV/BIP was greater than 12:1.

OVERBURDEN AND RECLAMATION MATERIAL STSOCKPILE LOCATIONS

All significant overburden and reclamation material stockpile locations were identified in the project area, and all of the sites identified were used in the mine design and planning. Section 5.3, Surface Facilities, provides more information on overburden and reclamation material stockpiles.

CRUSHER LOCATION

Relocatable crushers were selected to:

- complement the mine life sequencing
- minimize the haulage distance for the ore
- minimize the number of relocations that would be required

Relocatable crushers were considered the most appropriate choice for oil sands material handling.

GRAVEL SOURCES

No coarse granular deposits were identified within the Pierre River Mine development area.

A review determined that, based predominately on proximity, the Susan Lake granular deposit would be the likely granular source for the Pierre River Mine.

BASAL AQUIFER DISPOSAL

The basal aquifer must be locally depressurized for mining. The natural water quality is not suitable for discharge to the environment without processing, and the intent is to maximize water use within the site. The preferred method was to use this water in the extraction process. Therefore, further alternatives were eliminated.

WASTE HANDLING

Waste will be managed in an environmentally responsible manner that will comply with all regulatory and Shell corporate requirements. The priority principles of minimization, reuse, recycling and recovery will be followed. Alternatives for waste handling methods were not studied. Further optimization of waste handling methods will be considered as the project development advances. For further information on waste handling, see Section 11, Waste Management.

PURPOSE

An ETDA will be required to store tailings before in-pit tailings disposal becomes available. The ETDA was designed to store the first 12 years of tailings, during which time sufficient space can be developed within the mined pit.

ALTERNATIVES ASSESSED

Three potential tailings disposal sites were evaluated (see Figure 13-2).

Alternative Tailings Site 1

Alternative Site 1 is located on Lease 17 about 1.5 km west of the Athabasca River and 200 m north of oil sands Lease 14. This location would provide sufficient area without affecting mine operations, but it was ruled out because of environmental concerns associated with the proximity of the site to the Athabasca River.

Alternative Tailings Site 2

Alternative Site 2 is also located on Lease 17, about 2 km west of the Athabasca River and 1.6 km north of oil sands Lease 14. Site 2 was chosen as the preferred alternative, as it is further from the Athabasca River than Site 1 and did not sterilize potential ore.

Alternative Tailings Site 3

Alternative Site 3 is also located on Lease 17, about 6.2 km west of the Athabasca River and 200 m north of oil sands Lease 14. Site 3 was ruled out because preliminary exploration drilling results identified potential mineable ore within the footprint.

SELECTED ALTERNATIVE

The three alternatives evaluated were assessed only on primary criteria (economics, technical and operations, and environmental), because the three options were considered equal in terms of economic, and technical and operations considerations. Alternative 2 was selected because it is further away from the Athabasca River and will not sterilize future potential ore.

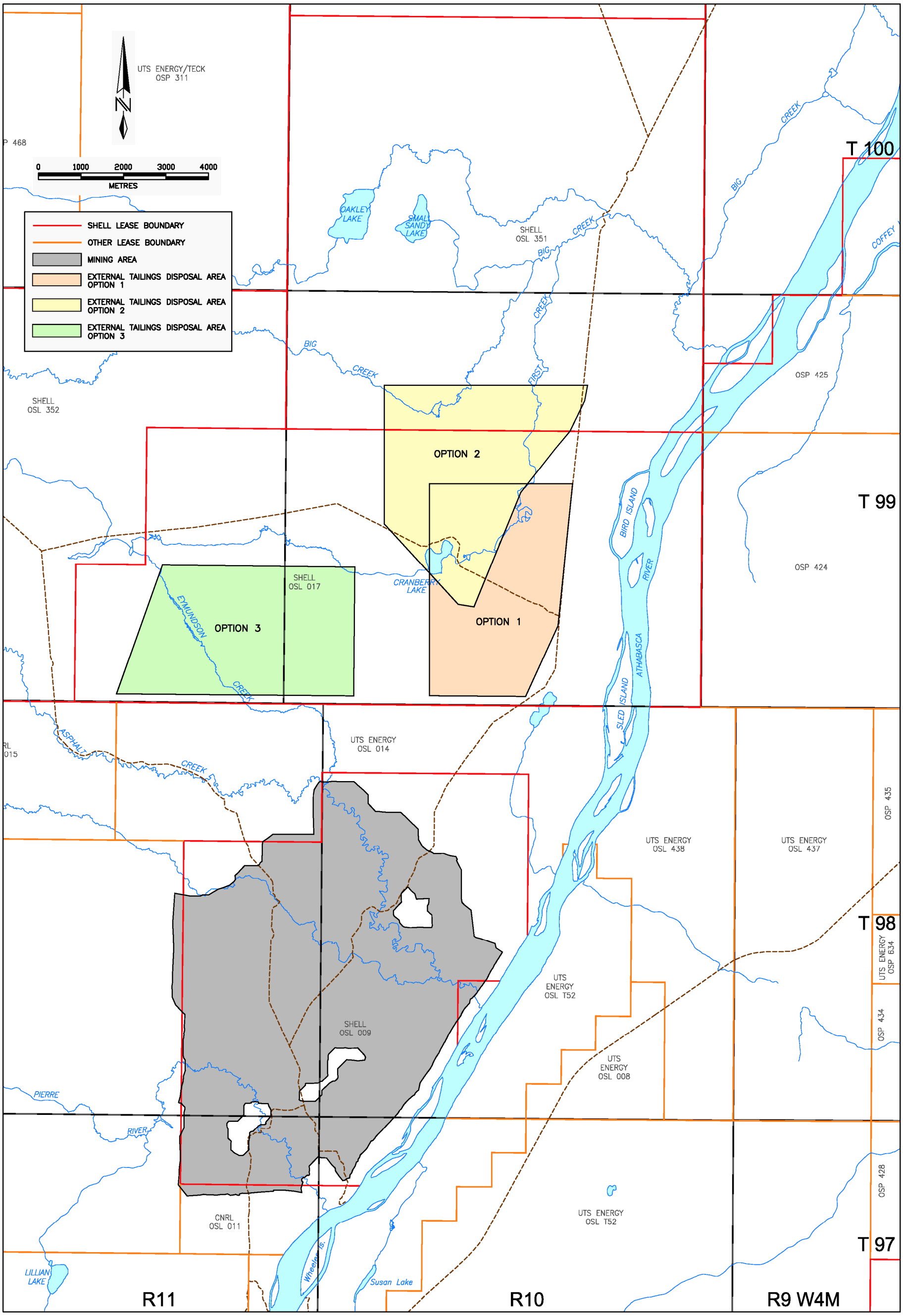


Figure 13-2: External Tailings Disposal Location Alternatives

PURPOSE

Existing streams with defined upstream headwaters outside the development area, and which traverse the Pierre River Mine development area, must be diverted to allow for mining and project development. Each stream diversion affects the choices available for the diversionary paths of the other streams in the area. Stream diversions also affect neighbouring developments.

ALTERNATIVES ASSESSED

Four stream diversion alternatives representing the technically viable options for each stream in the development area were studied.

Four streams will be affected (see Figure 13-3) in the Pierre River Mine development area:

- Pierre River
- Unnamed Creek 1
- Asphalt Creek
- Eymundson Creek

Alternative A – North Diversion

Pierre River, Unnamed Creek 1, Asphalt Creek and Eymundson Creek would be diverted north around the Pierre River Mine development area, through the Teck/UTS joint venture on Lease 14, to the Athabasca River (see Figure 13-4). The diversion of these streams would require the construction of a diversion channel with three reaches:

- Ditch C
- Ditch D
- Ditch E

Before the scheduled start of mining operations in 2018, Ditch C and Ditch D would be constructed in 2016 to divert Unnamed Creek 1, Asphalt Creek and Eymundson Creek. These diversions would allow for mine development activities in the northwestern area of the Pierre River Mine development area.

Alternative A – North Diversion (cont'd)

The progression of mining activities to the south would require the diversion of the Pierre River by Ditch E to Ditch D in 2030. Diverted flows in the ditches would be received by Big Creek and then flow into the Athabasca River.

Alternative B – South Diversion

Eymundson Creek, Asphalt Creek, Unnamed Creek 1 and the Pierre River would be diverted south around the Pierre River Mine development area to the Athabasca River. The diversion of these streams would require constructing Ditch F (see Figure 13-5). Ditch C would be constructed in 2016 to divert the lower drainage area of Asphalt and Eymundson creeks.

Staging Ditch F diversion was also an option that was considered within this alternative. This option would require Eymundson Creek, Asphalt Creek and Unnamed Creek 1 to be diverted to the Pierre River from 2016 to 2030. Because of a southward mine advance eventually crossing this area, this diversion to the Pierre River would be discontinued in 2030, and Ditch F would be extended further south to divert the Pierre River, and the previously diverted Eymundson Creek, Asphalt Creek and Unnamed Creek 1, to Big Creek and then into the Athabasca River. This staged diversion plan would increase stream flow by more than 50%, based on drainage area ratio, in the Pierre River and would result in an undesirable morphologic alteration of the Pierre River. For this reason, the staged Ditch F diversion system was not adopted.

Alternative C – Surge Pond

This option requires constructing three surge ponds to collect natural runoff (see Figure 13-6), which would be conveyed by a forced system (pump and pipeline) to the Athabasca River:

- Surge Pond 1 would collect flows from Eymundson and Asphalt creeks in 2016
- Surge Pond 2 would collect flows from Unnamed Creek 1 in 2016
- Surge Pond 3 would collect flows from the Pierre River in 2030

The surge ponds will be designed to contain inflows during a 100-year flood event, assuming the surge pond pumps are operating at maximum capacity. Surge pond outflows would be discharged to the Athabasca River through pipelines. A conceptual design of the surge ponds assumes:

- a freeboard of 1 m below mineral soil elevation
- wall side slope of 3H:1V
- a muskeg depth of 2 m
- a total surge pond depth of 12 m below ground elevation

The preliminary design suggests that the surge ponds can be sized to have a surface area of about 1 to 2.5 km². Using surge ponds allows for controlled flow, but eliminates all natural flow and connectivity between the Athabasca River and the diverted streams.

Alternative D – Split Diversion

This option requires the Pierre River and Unnamed Creek 1 to be diverted south by Ditch H in 2016 around the Pierre River Mine development area to the Athabasca River (see Figure 13-7). Flows in Eymundson and Asphalt creeks will be diverted north by Ditch C through the Teck/UTS joint venture Lease 14 to the Athabasca River. These diversions are expected to increase stream flow by more than 50%, based on drainage area ratio, resulting in an undesirable morphologic alteration in the Pierre River.

SELECTED ALTERNATIVE

The alternatives evaluated were assessed on primary criteria (economics, technical and operations, and environmental). Alternative D was selected as the preferred alternative because it had the least complex and expensive diversion scheme, i.e., higher economic, and technical and operations criteria. Alternative D also fulfilled environmental criteria as it maintained connectivity to the Athabasca River and the Pierre River, and the diversion will remain intact at closure.

Alternatives A and B were similar to Alternative D in their technical assessments. However, they were more complex to build than Alternative D. Alternatives A and B also created more disruption of fish habitat than Alternative D and affected more stream length and flow.

Alternative C was the least feasible alternative, because it required a high-cost and operationally more complex pumping system, and did not maintain connectivity to the Athabasca River.

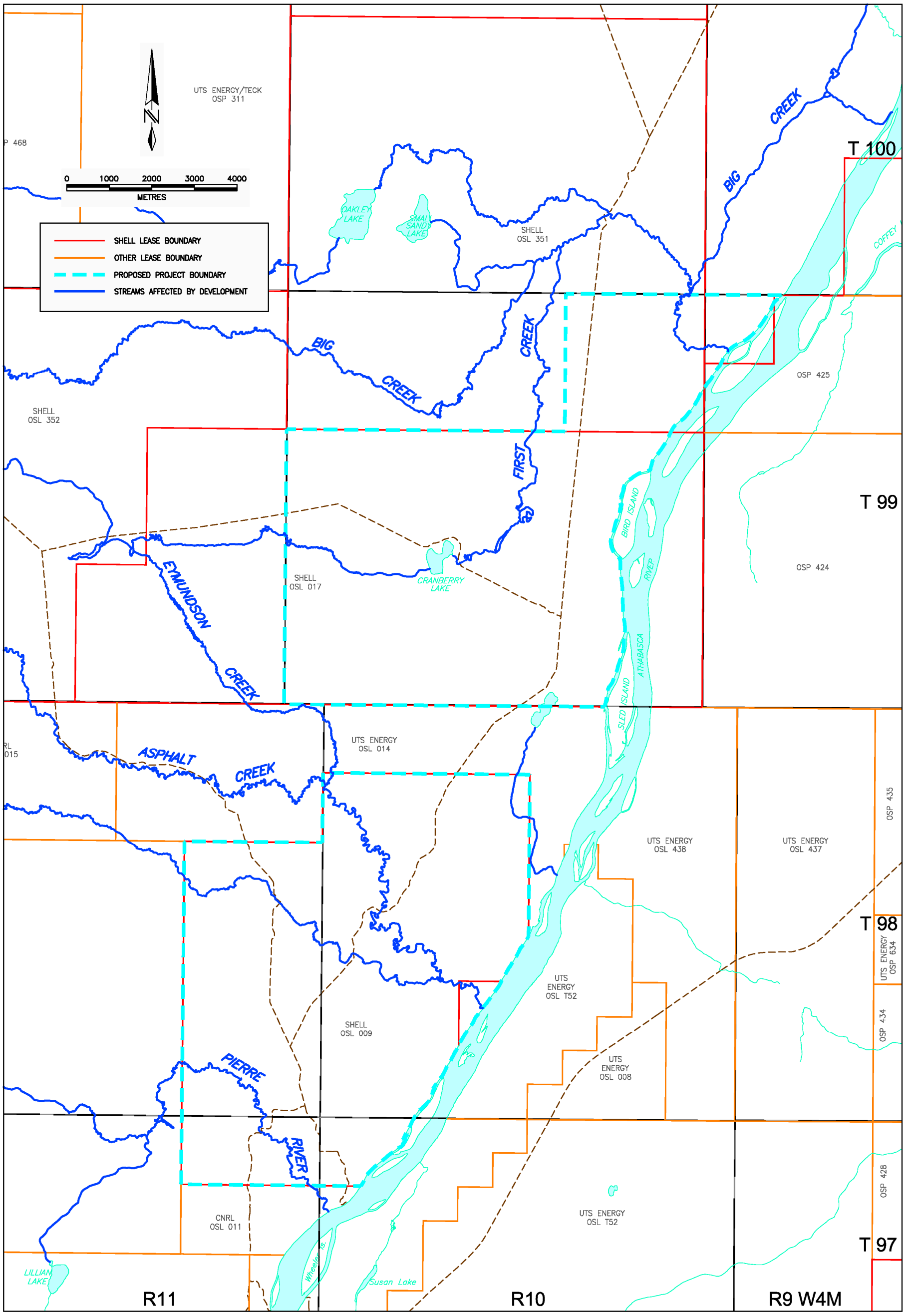


Figure 13-3: Streams Affected by Development

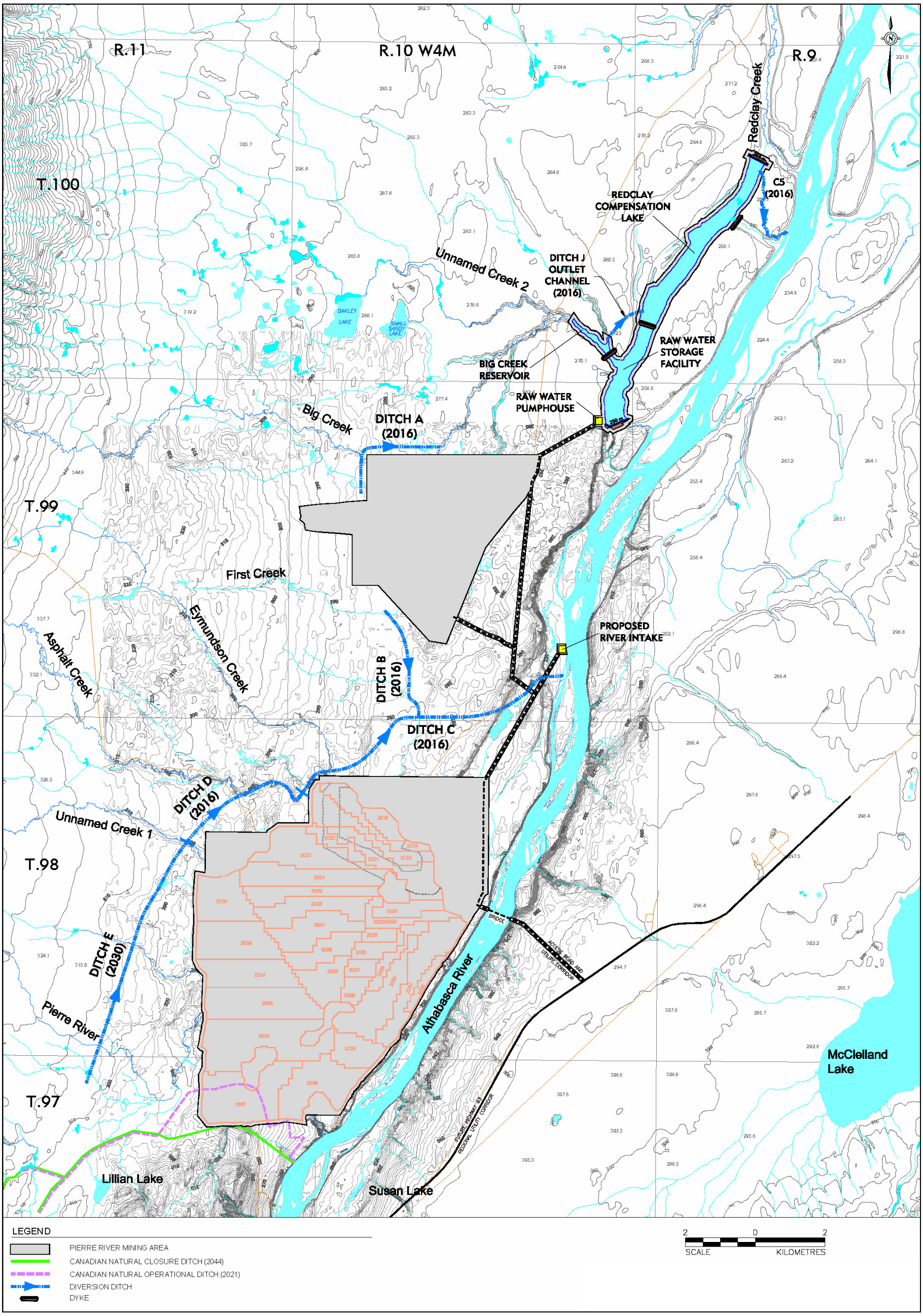


Figure 13-4: Alternative A – Stream Diversions

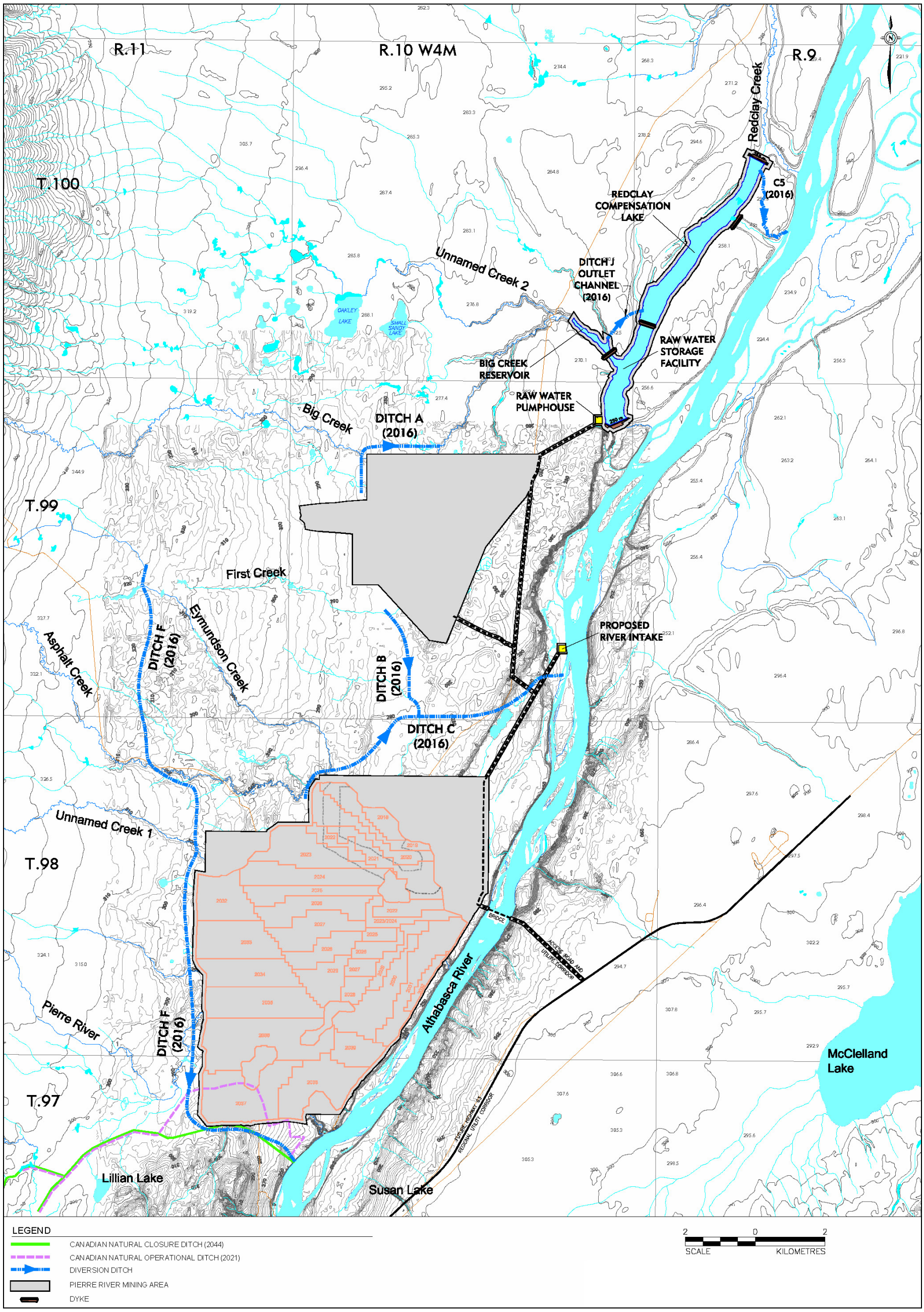


Figure 13-5: Alternative B – Stream Diversions

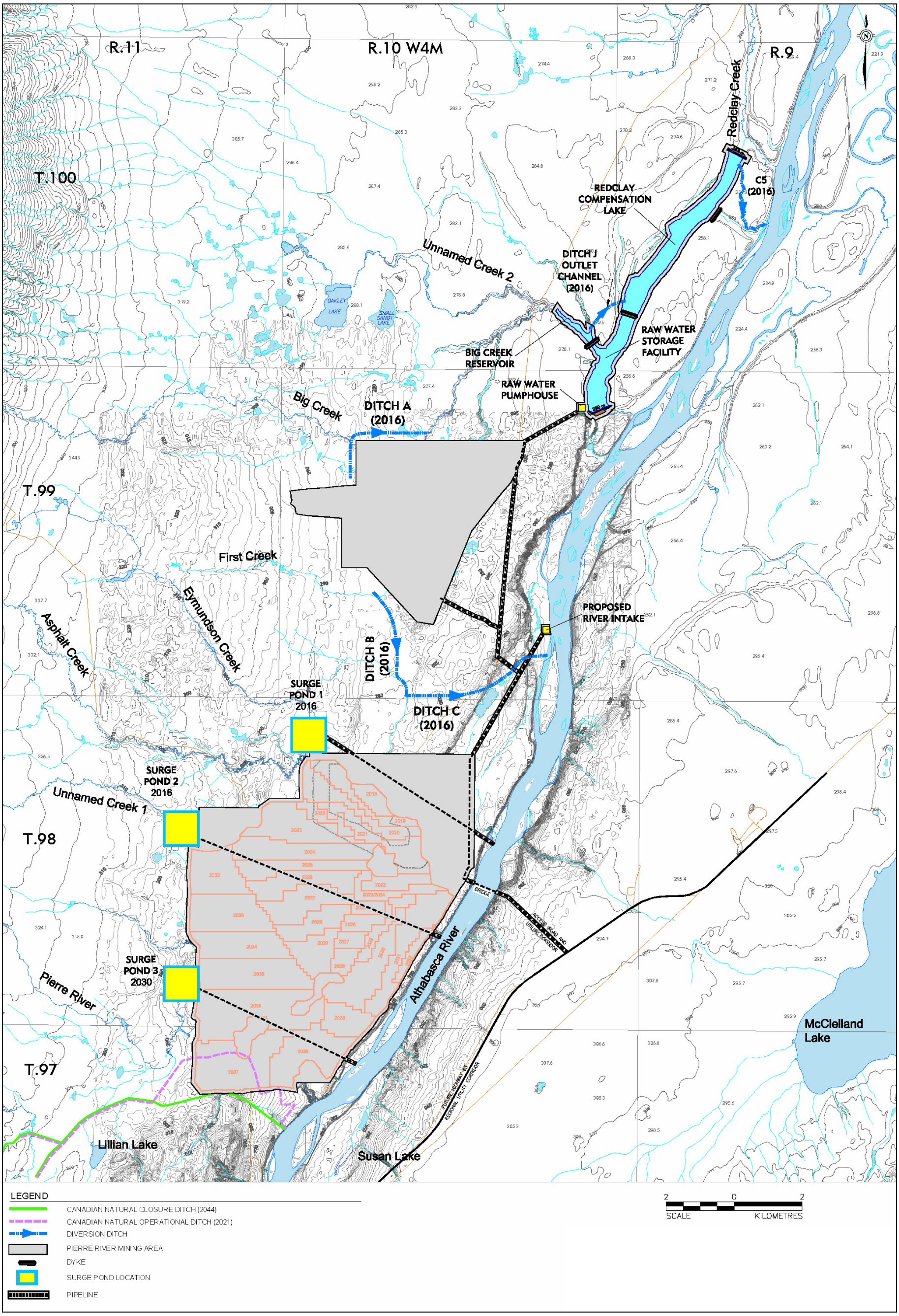


Figure 13-6: Alternative C – Stream Diversions

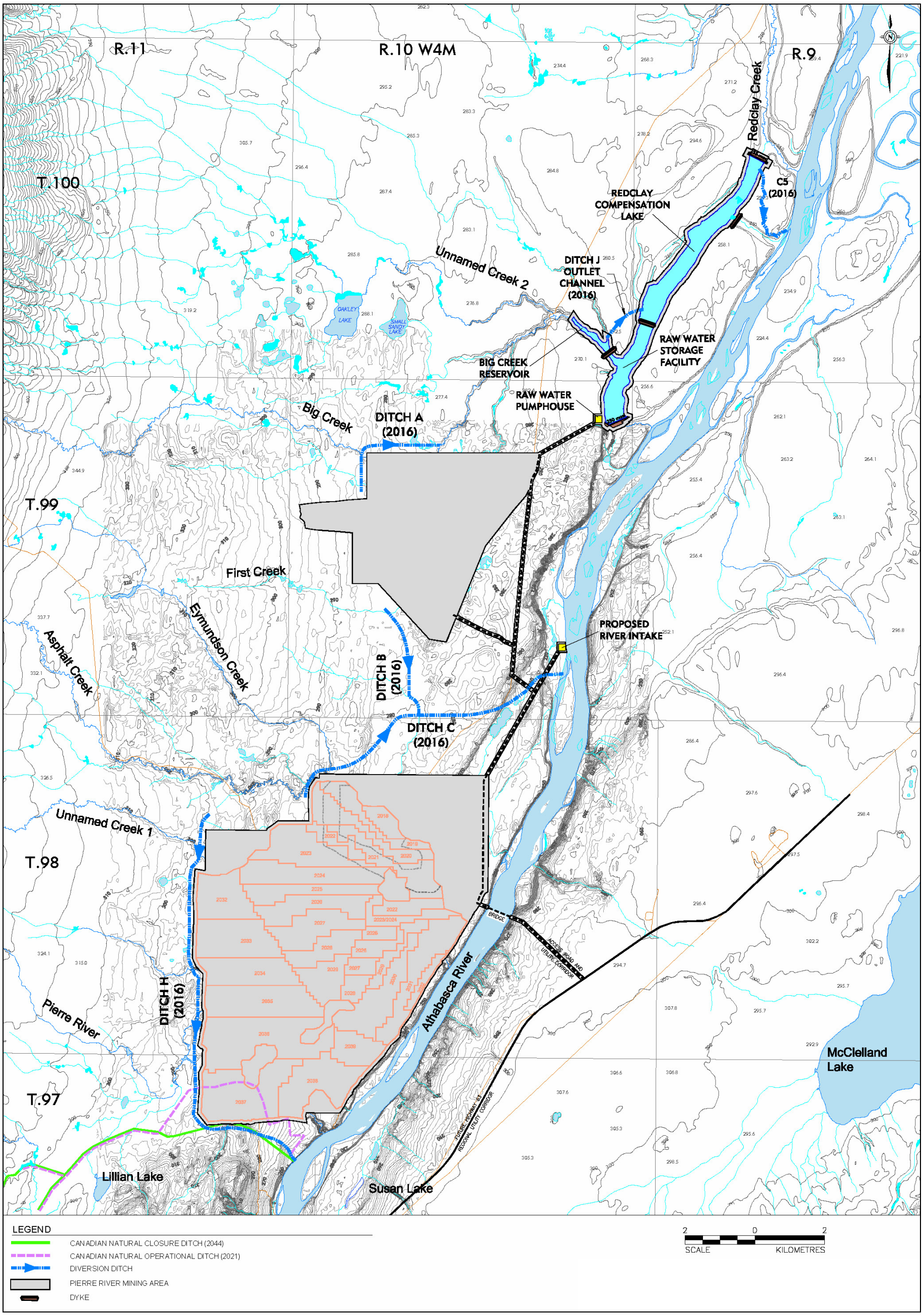


Figure 13-7: Alternative D – Stream Diversions

PURPOSE

The workforce must be able to travel safely to the project area, on either a common public corridor or a private road. Wherever possible, using an existing common road corridor is preferred, as this minimizes terrestrial disturbance. However, roads must also be assessed to determine the capacity for increased load sizes or traffic volume.

ALTERNATIVES ASSESSED

Figure 13-8 shows the four access alternatives for the Pierre River Mine.

Alternative 1 – West Access

The nearest public roadway on the west side of the Athabasca River is Highway 63, at the intersection with the access road to the community of Fort McKay. Access could be established from Highway 63, north on the Fort McKay access road, and progressing onto the Canadian Natural Resources Limited (CNRL) private road north for about 10 km to the CNRL Horizon Project plant site, which is currently under construction.

This alternative would require extending the CNRL access road by about 30 km to the Pierre River Mine plant site. To minimize the potential impacts, the extension is expected to be within the environmental buffer of the Athabasca River.

Alternative 2A – North Crossing

This is the northernmost access route and bridge crossing location considered. The 4-km-long access road will begin near the centre of the proposed plant site and will progress across the Athabasca River to intersect with the Fort Chipewyan winter road near kilometre marker 45 (see Figure 13-9). To reach the access road, about 29 km of the Fort Chipewyan winter road will require upgrading. Because the river narrows, and given the required bridge geometry, the access road will require a significant embankment for the bridge approaches. To provide the volumes of earth required, borrow pits will need to be excavated on either side of the Athabasca River.

Alternative 2B – Middle Crossing

The 3.5-km-long access road would begin at the southernmost tip of the proposed plant site and progress eastward across the Athabasca River to intersect the Fort Chipewyan winter road near kilometre marker 44 (see Figure 13-10). To reach the access road, about 28 km of the Fort Chipewyan winter road would require upgrading. The bridge design profile suggests that some excavation of the top bank of the Athabasca River would be required to bring the road down to the bridge. This access provides the best passage for wildlife.

Alternative 2C – South Crossing

The southern access route would begin at the southernmost tip of the proposed plant site (see Figure 13-11). The road alignment would progress south for about 6.8 km through the proposed mine site along the west side of the Athabasca River to the bridge crossing location. Of the alternatives considered, this bridge would be located at the narrowest part of the Athabasca River. After crossing the Athabasca River, the road would follow a southeast course up the gradually sloping river valley for 5.5 km, to intersect with the Fort Chipewyan winter road at about kilometre marker 34. The 6.8 km of access road on the west side of the Athabasca River would also require a bridge crossing of Eymundson Creek.

SELECTED ALTERNATIVE

Alternative 2A was selected because of technical and environmental criteria. This alternative will minimize disturbances, maximize winter road use and use the shortest route.

Alternative 2B resulted in the fewest environmental concerns relative to the other alternatives, but the bridge location created significant economic and technical challenges.

Alternative 2C was a more economical alternative than 2B. However, Alternative 2C required more material for construction, i.e., operational complexity, and did not provide the most direct route from Fort McMurray.

Alternatives 2A and 1 were more expensive than Alternatives 2B and 2C, and required more material for construction. Alternative 2A required the use of abutment blocks at either end of the bridge. This would block wildlife corridors. Alternative 1 had the longest route, required widening existing roads, and required numerous small stream crossings.

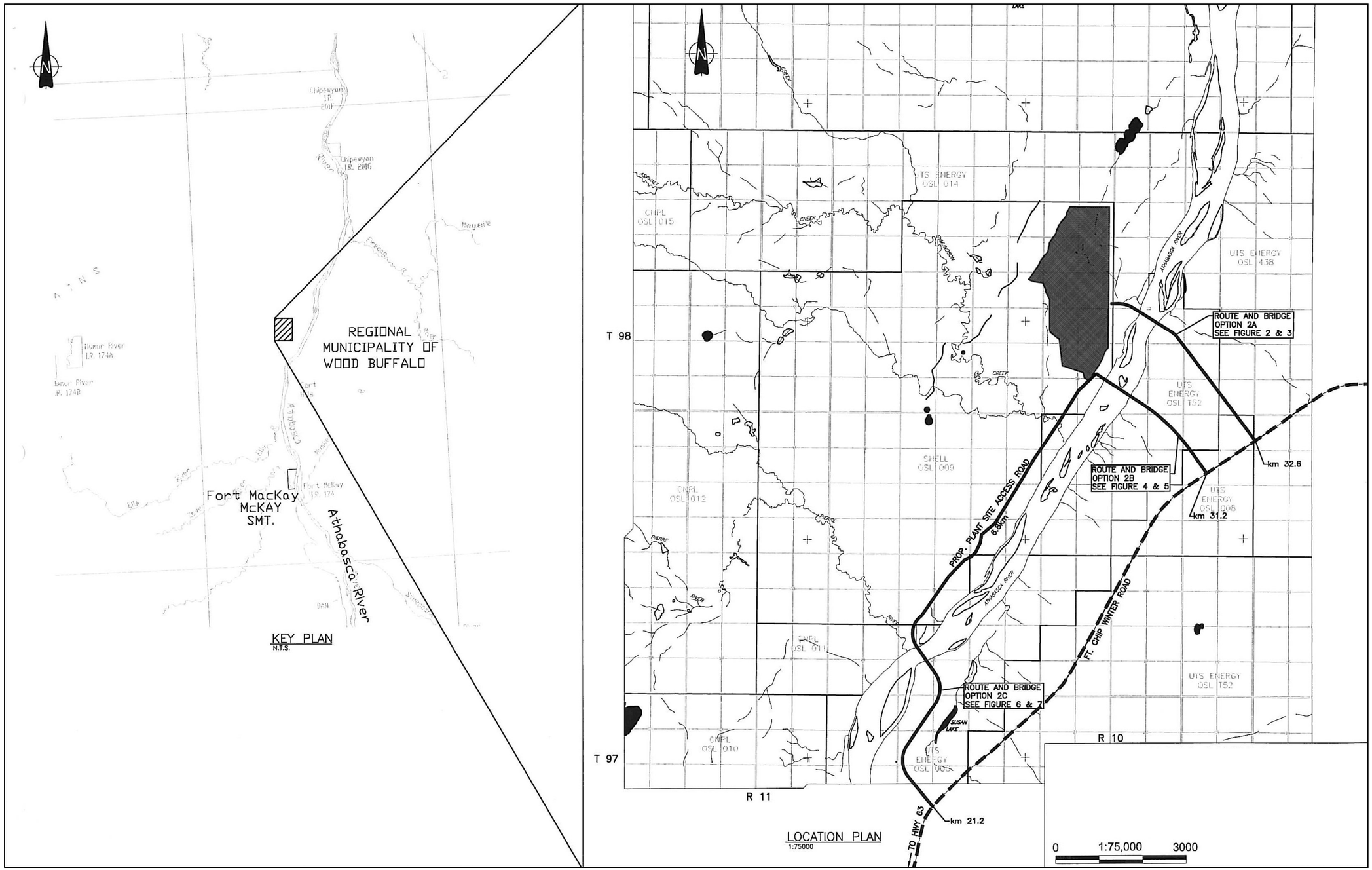


Figure 13-8: Bridge and Access Road Alignment Alternatives

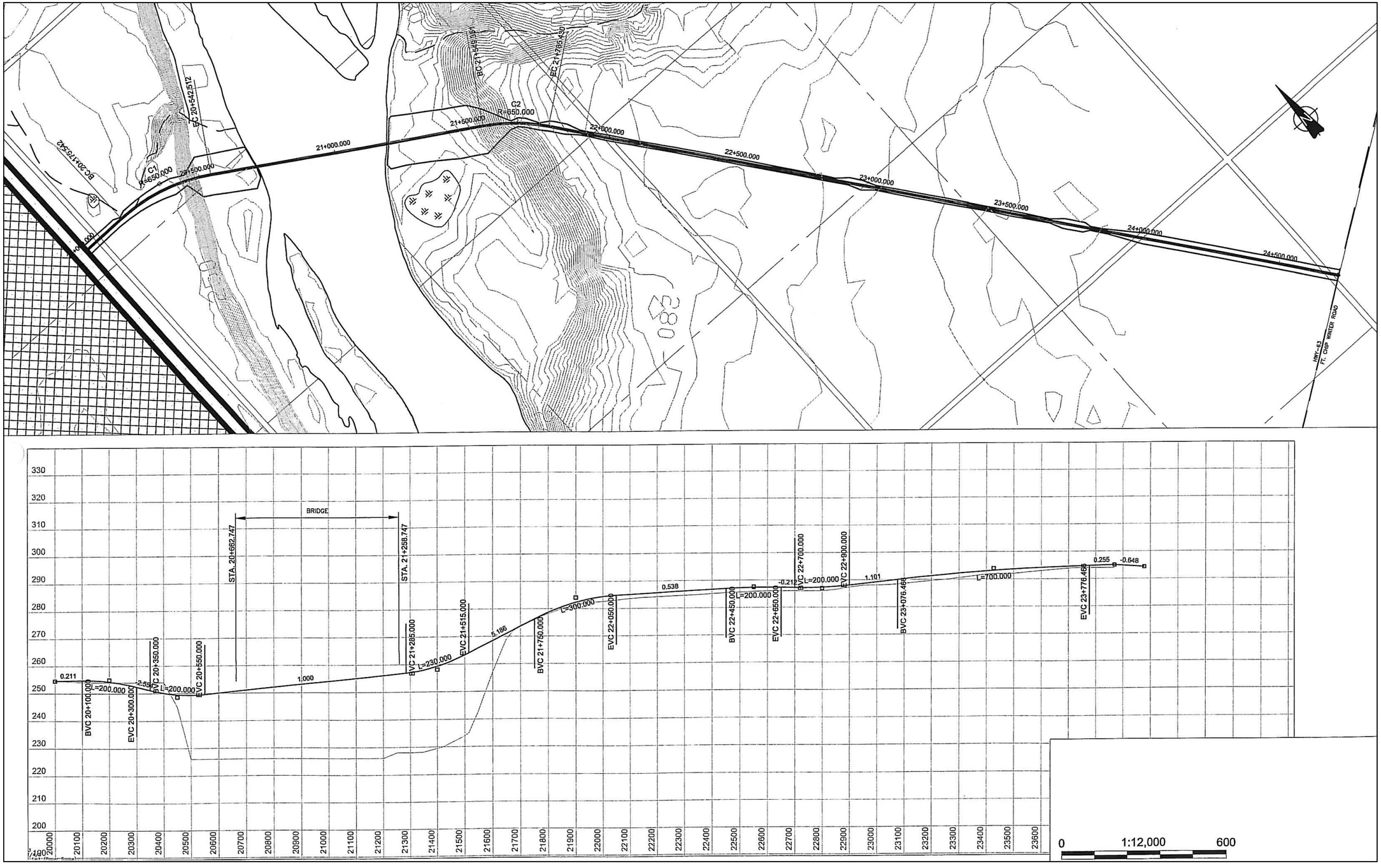


Figure 13-9: Alternative 2A – Bridge and Access Road

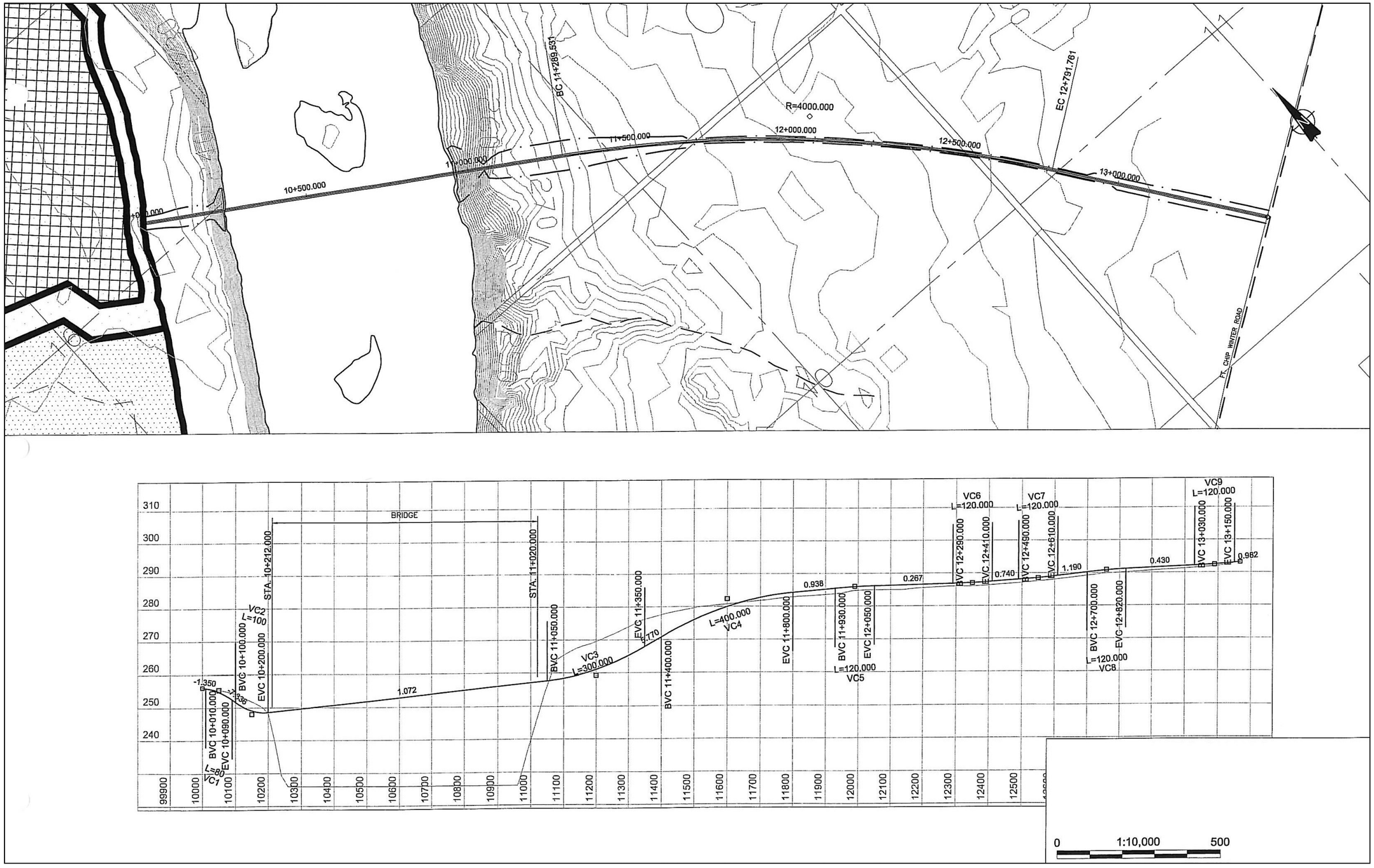


Figure 13-10: Alternative 2B – Bridge and Access Road

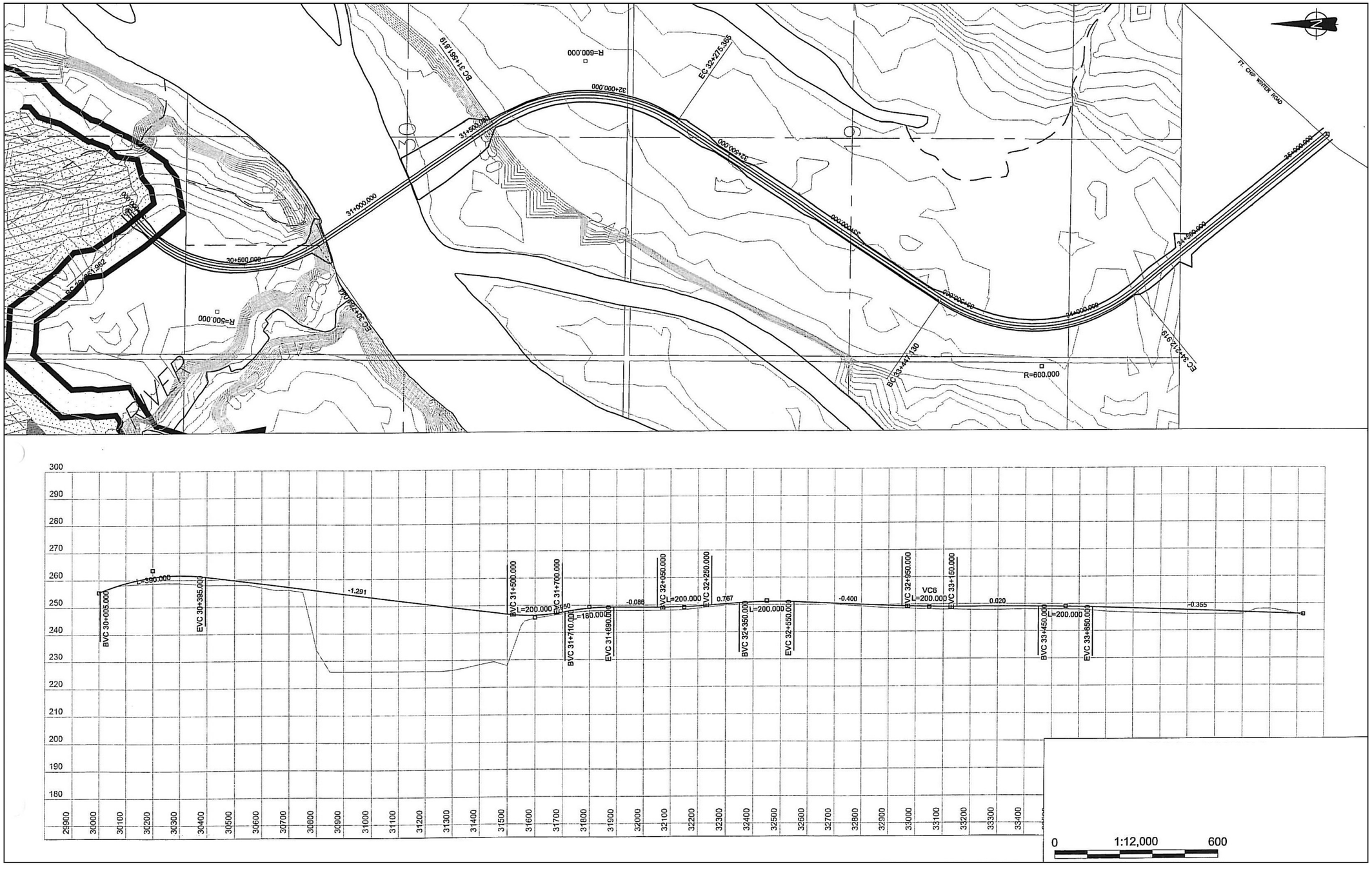


Figure 13-11: Alternative 2C – Bridges and Access Roads

PURPOSE

Cogeneration is the preferred system for providing power and steam for the Pierre River Mine processing facilities.

ALTERNATIVES ASSESSED

A number of cogeneration options are being considered for providing the main source of steam and electricity at the Pierre River Mine. A secondary natural-gas-fired cogeneration facility is planned as a backup. The options for the main facility include:

- an asphaltene energy recovery (AER) unit with conventional boiler technology
- a natural-gas-fired facility

The AER technology is of interest because it makes use of an otherwise waste stream as a source of energy, thereby reducing overall dependence on natural gas as a source of energy for the proposed project. Shell is evaluating further improvements to this technology, such as oxygen firing, that could reduce the overall emissions to the equivalent of gasification with a future carbon capture-ready option.

The comparison of the two alternatives was based on:

- improved resource use
- environmental factors
- existing technology risks
- long-term national energy sustainability
- associated capital and operating cost estimates for each option

Alternative A – Natural Gas Turbine Cogeneration

Alternative A is a single natural gas turbine generation (GTG) system with a heat recovery steam generation (HRSG) system (see Figure 13-12).

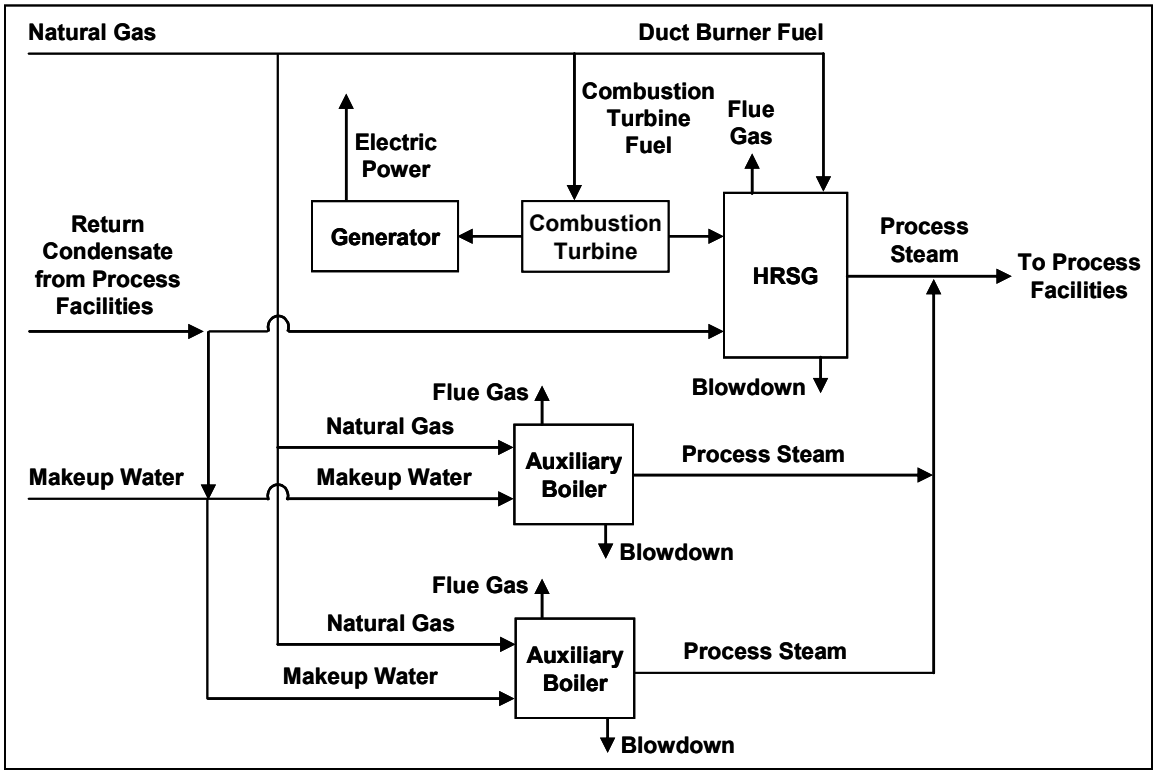


Figure 13-12: Alternative A – Natural Gas Turbine Cogeneration

Alternative B – Asphaltene Fired Cogeneration

Alternative B is a solid waste fuel cogeneration boiler and a steam turbine with environmental units (see Figure 13-13).

New technology for solid fuel boilers might allow the units to be designed to be ready for CO_2 capture and potential future sequestration.

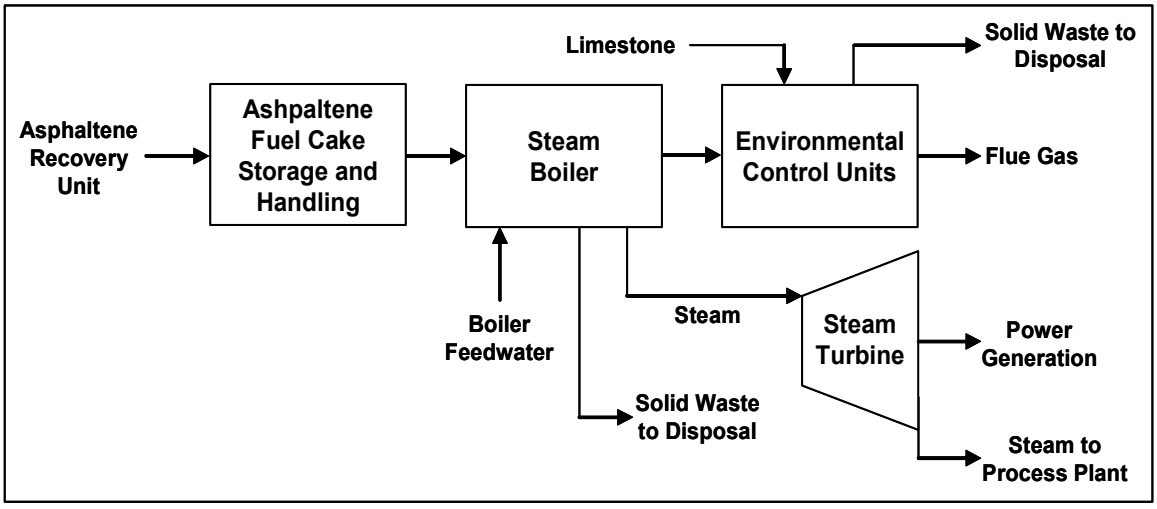


Figure 13-13: Alternative B – Asphaltene Fuelled Cogeneration

SELECTED ALTERNATIVE

A solid waste fuel cogeneration system (Alternative B) for the mine steam and power generation was selected for the Application Case. The solid fuel cogeneration system will provide a high level of sustainable development for Shell and its stakeholders by:

- reducing the use of a clean fuel (natural gas) to produce synthetic crude oil, thereby reducing the consumption of a non-renewable, depleting resource
- improving resource recovery by reducing Shell's energy intensity, by looking for alternative energy sources, such as waste products currently disposed of in tailings
- reducing the oil sands industry's long-term storage requirements by reducing the volume of hydrocarbons included in the tailings
- contributing to a decrease in volatile organic compounds (VOCs) in the tailings. More of the diluent may be captured more efficiently, and the remaining diluent that is bound to waste products will be combusted and used as an energy source.

In addition, although the combustion of solid fuel will generate more CO_2 than would be generated using natural gas, technology is expected to be developed that will capture CO_2 for sequestration, if infrastructure is available in the future.

PURPOSE

Alternatives were considered for a suitable site and conceptual intake design for the raw water supply from the Athabasca River.

ALTERNATIVES ASSESSED

Three water intake alternatives, representing technically viable locations on an 18 km stretch of the Athabasca River, were studied (see Figure 13-14). A fourth site was identified 10 km north of Alternative A, but this site was not considered because of the distance to Shell's Lease 9.

Alternative A – Sled Island

Alternative A, located about 3 km downstream (north) of Sled Island, is north of the Lease 9 boundary. A thalweg is close to the west bank between two large islands:

- Sled Island, upstream of the site
- Bird Island, downstream of the site

Historical aerial photographs show active sand bars downstream and adjacent to the site. A large sand bar was observed in the middle of the river just upstream of Bird Island.

Navigation charts show a shift in route from the west bank in 1973 to the east bank in 1996. Because of the potential for thalweg movement in this area, river training structures, such as rock-protected riverbank extensions, might be needed in the future to control the location of the thalweg along the west bank.

The riverbank at this site is along a low, flat terrace area, about 500 m wide, which ranges up to a few metres above normal high water. Peak flood events might flood the area between the proposed site and the west valley wall.

This area was likely formed by fluvial deposition of the Athabasca River and is expected to be composed of silt, sand and gravel overlying bedrock at depth. The depth to bedrock at the proposed intake site might be considerable.

Alternative A – Sled Island (cont'd)

An intake could be constructed at this location. However, deep foundations might be required. Excavations below river level will have a substantial dewatering challenge.

A low-lying wet area exists between the proposed intake site and the west valley wall. A review of historical aerial photographs shows a series of old slope failures along the west valley wall. Selection of a pipeline route up this slope should consider the potential for post-construction slope movement.

The riverbank at this location is considerably more erodible than the other sites examined.

Alternative B – Eymundson Creek

Alternative B, located near Eymundson Creek, about 8 km upstream (south) of Sled Island, is located midway between the north and south boundaries of Shell's Lease 9.

Alternative B is located in a wide, straight reach of the Athabasca River that is characterized by numerous sand bars and a few vegetated islands. The sand bars have been active and the thalweg might be vulnerable to shifting because of these conditions. Therefore, this site is less than favourable for a river water intake.

Suitable foundations could probably be established within the McMurray Formation materials, provided active large-scale failures do not exist at the chosen location. Alternatively, significant slope grading might be required to provide a stable setting for the intake structure and associated pipeline and access route.

Alternative B contains erosional habitat, but also contains some rarer armoured habitat, which offers more unique habitat characteristics that are favoured by a larger selection of fish.

Alternative C – Pierre River

Alternative C, located near the Pierre River about 15 km upstream (south) of Sled Island, is just south of the Lease 9 boundary. Because Alternative C has the most notable outside curve in the river within the study reach, the thalweg is expected to remain along the west bank in the long term. This portion of the river is also narrow, with historical evidence of eroding banks. These conditions would suggest a permanent deep thalweg close to the west bank.

However, a shallow area causes the thalweg to shift east towards Wheeler Island, immediately after which the thalweg moves back to the west bank, downstream of the Pierre River. The shallow area might be a result of slumping banks or an outcrop of bedrock. Flow might erode this shallow area and relocate the thalweg, although the likelihood of such an occurrence is unknown.

Alternative C would be the most sensitive location for an intake, because of the diversity and uniqueness in habitat types present and the number of fish species that prefer those habitat types.

SELECTED ALTERNATIVE

Alternative A (Sled Island) was chosen as being the most suitable location for a river water intake. Alternative A was selected because it:

- had the smallest disturbance area
- had the lowest fisheries disturbance, as it was not located near any tributaries that are potential areas for spawning
- is further away from the riverbank, providing more flexibility for construction and preventing pump station construction within the valley wall

Alternative C also had a good location from a river engineering perspective because of a deep thalweg close to the west bank. However, it was ruled out because the preliminary fish habitat assessment identified it as the most sensitive site.

Alternative B was ruled out because the high valley wall would require larger cut volumes for the facility footprint and the access road, compared to those required for Alternative A.

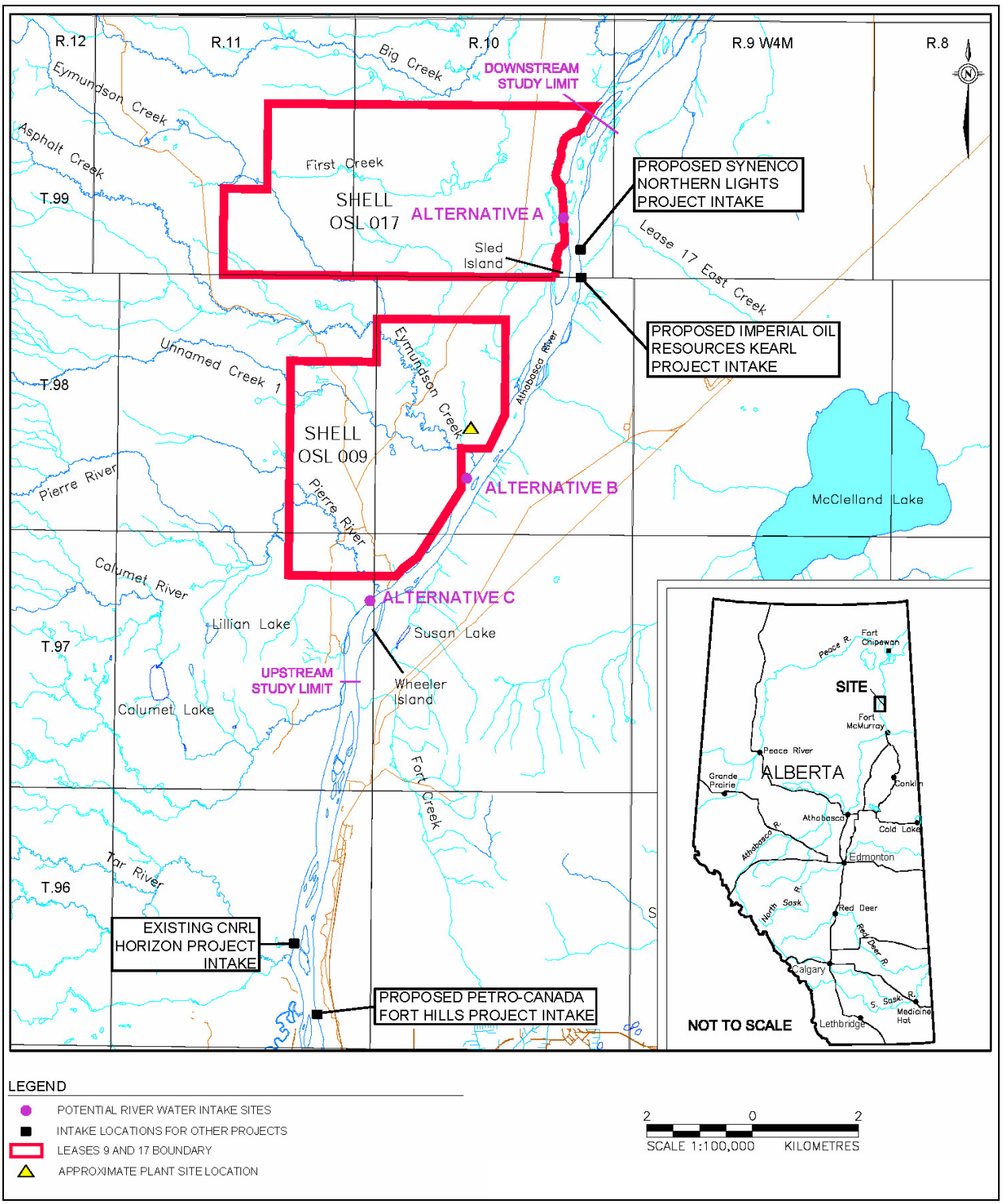


Figure 13-14: Raw Water Intake Location Alternatives

PURPOSE

Alternatives were considered for a conceptual intake design for the raw water supply from the Athabasca River.

ALTERNATIVES ASSESSED

Alternative A – Low-Level Pipe Intakes

The key considerations for low-level pipe intakes (see Figure 13-15) are:

- two low-level intake pipes
- a pump station would be set on fill, set back from the riverbank
- bank erosion protection would be required
- intake pipes might be installed by auguring from a pump well
- cylindrical fish screens would be installed at the end of each pipe, which might be difficult to access
- fish screens would be vulnerable to ice damage
- a high-pressure air system would be required for screen cleaning
- pile supports at the pipe ends could be installed on top of ice
- fish screens could be installed by divers
- a minimal bed and bank disturbance would result
- a modest compensation for loss of fish habitat would result

Alternative B – Low and High-Level Pipe Intakes

Figure 13-16 shows the features of low and high-level pipe intakes. The considerations for a low-level pipe intake are the same as for Alternative A. The key considerations for high-level pipe intakes are:

- cleaner water could be drawn off during periods of high flow and high sediment concentrations
- the pipes could be mostly constructed in dry conditions

Alternative C – Pier-Type Bed Intakes

The key considerations for the pier-type bed intake (see Figure 13-17) are:

- single-level intake ports in reinforced concrete intake structure
- the pier shape promotes self-scouring
- the navigation requirement might not be met because of the structure height
- fish screens fitted within the intake ports would be difficult to access for maintenance
- a high-pressure air system would be required for screen cleaning
- a pump station would be set on fill, set back from the riverbank
- bank erosion protection would be required, i.e., riprap
- a sheetpile cofferdam would be required to construct an intake structure
- intake pipes might be installed by auguring from a pump well
- a modest compensation for loss of fish habitat would result

Alternative D – Bank Intake

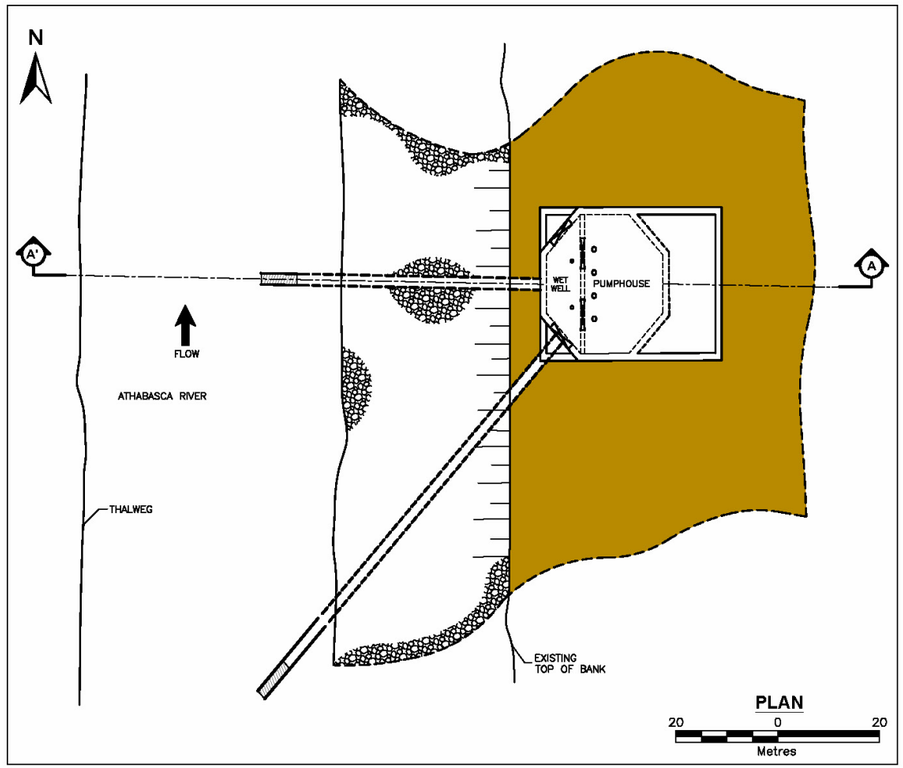
The key considerations for the bank intake alternative (see Figure 13-18) are:

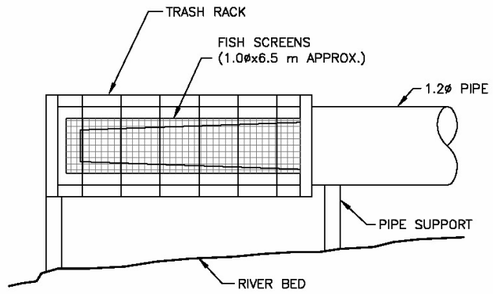
- a pump station and wet well will be built out from the riverbank to access river thalweg
- a retaining wall will be required along the riverbank
- high and low-level inlet ports will be required on the pump well wall
- high-level inlet ports will allow cleaner water to be drawn off during periods of high flow and high sediment concentrations
- fish screens will be installed on inlet ports, where they are accessible
- a high-pressure air system will be required for screen cleaning
- a sheetpile cofferdam will be required to construct the pump well
- a modest compensation for loss of fish habitat will result

SELECTED ALTERNATIVE

Alternative D was chosen because of technical and environmental criteria. It provided the least river disturbance and the best options for maintenance and accessibility at a moderate cost.

Alternative A was a less expensive option and minimized riverbank disturbance. However, it allowed limited or no access to screens, created a high potential for ice damage and would be difficult to maintain. Alternative B was also less expensive than Alternative D, but it was also technically less feasible. Alternative C was the most expensive option, and had the most environmental concerns.





FISH SCREENS - DETAIL
N.T.S.

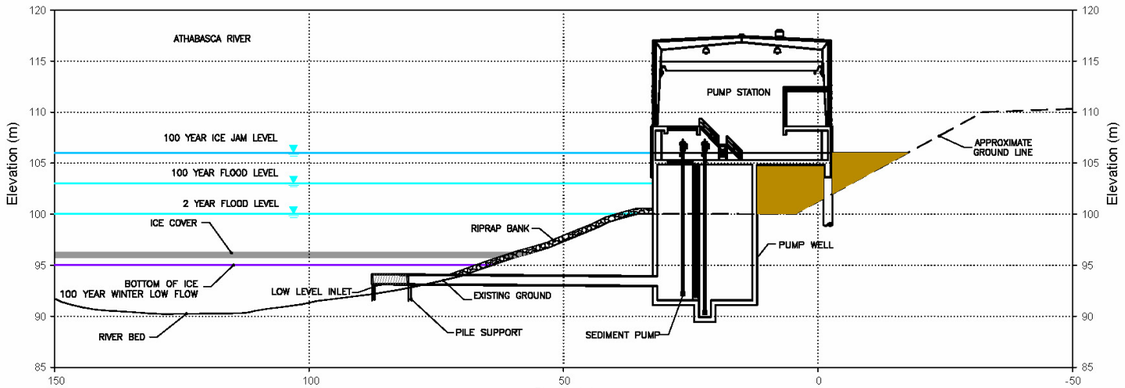
LEGEND

COMPACTED FILL

RIPRAP

NOTES

1. ALL ELEVATIONS ARE REFERENCED TO LOCAL DATUM (TEMPORARY BENCHMARK)
2. ELEVATIONS SHOWN ARE APPROXIMATE ONLY

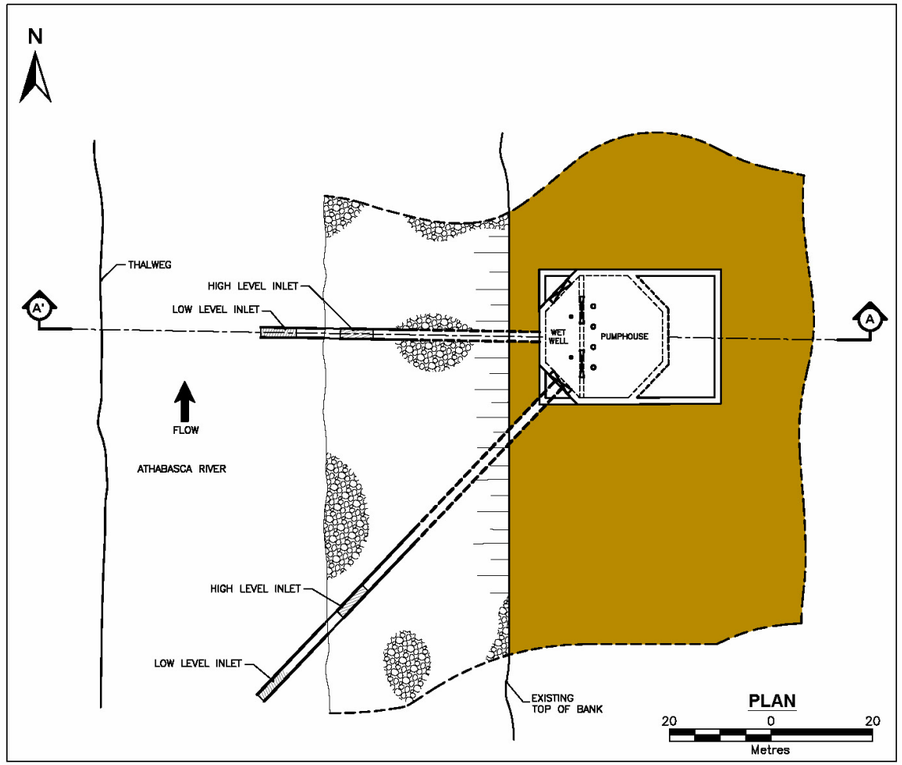


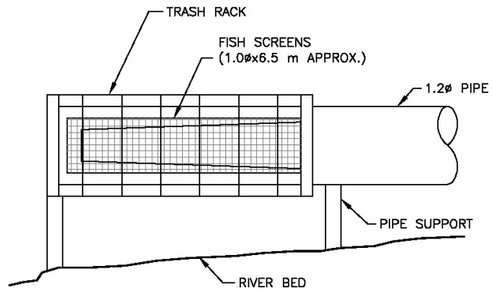
A CROSS-SECTION (CENTRE LINE)

20 0 20 Metres Horizontal

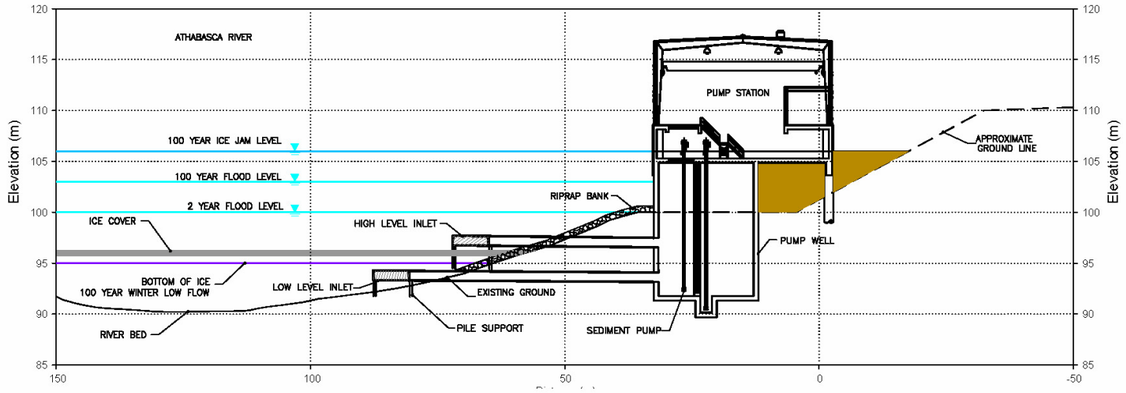
10 0 10 Metres Vertical

Figure 13-15: Alternative A – Raw Water Intake Design





FISH SCREENS - DETAIL
N.T.S.



A

CROSS-SECTION (CENTRE LINE)

20 0 20
Metres
Horizontal

10 0 10
Metres
Vertical

LEGEND

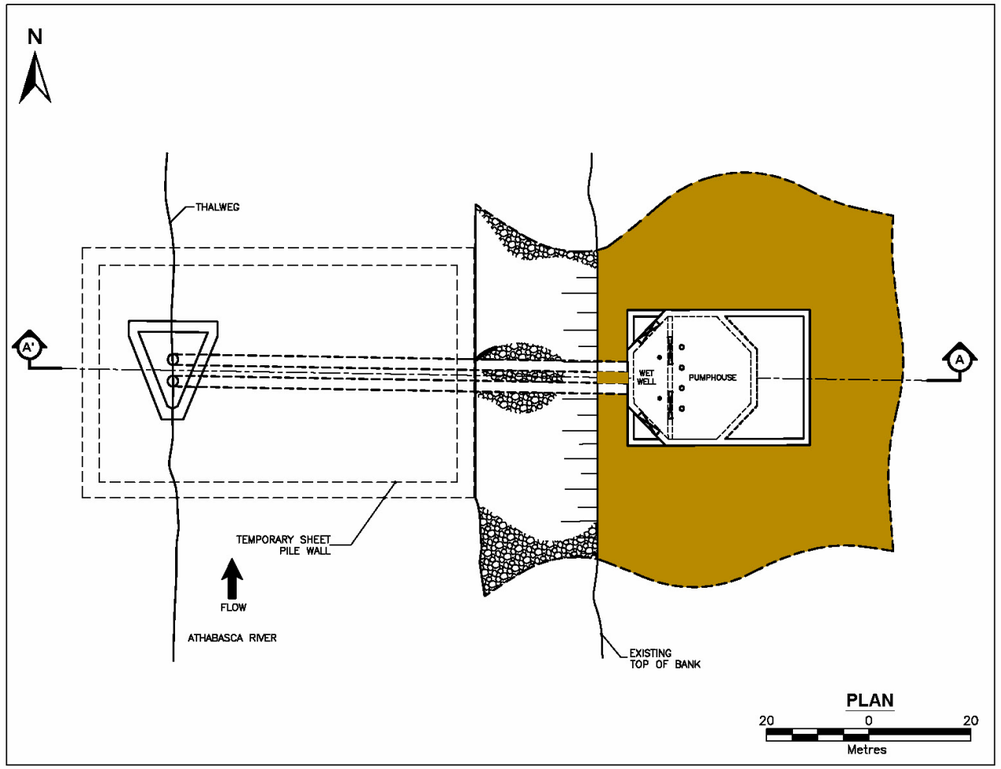
COMPACTED FILL

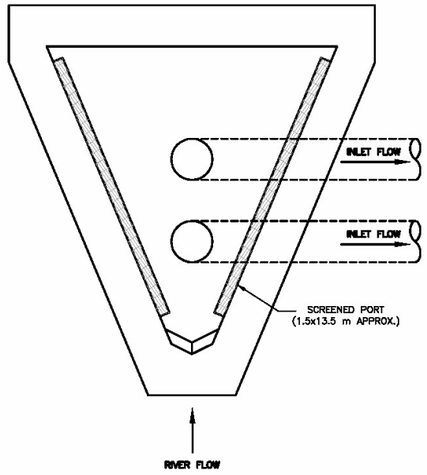
RIPRAP

NOTES

1. ALL ELEVATIONS ARE REFERENCED TO LOCAL DATUM (TEMPORARY BENCHMARK)
2. ELEVATIONS SHOWN ARE APPROXIMATE ONLY

Figure 13-16: Alternative B – Raw Water Intake Design





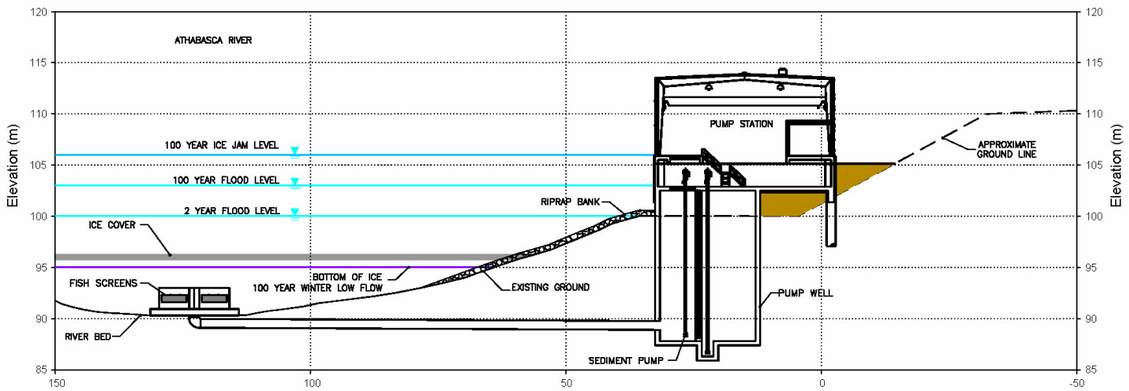
BED INTAKE - DETAIL
N.T.S.

LEGEND

- COMPACTED FILL
- RIPRAP

NOTES

1. ALL ELEVATIONS ARE REFERENCED TO LOCAL DATUM (TEMPORARY BENCHMARK)
2. ELEVATIONS SHOWN ARE APPROXIMATE ONLY



A

CROSS-SECTION (CENTRE LINE)

20 0 20 Metres Horizontal

10 0 10 Metres Vertical

Figure 13-17: Alternative C – Raw Water Intake Design

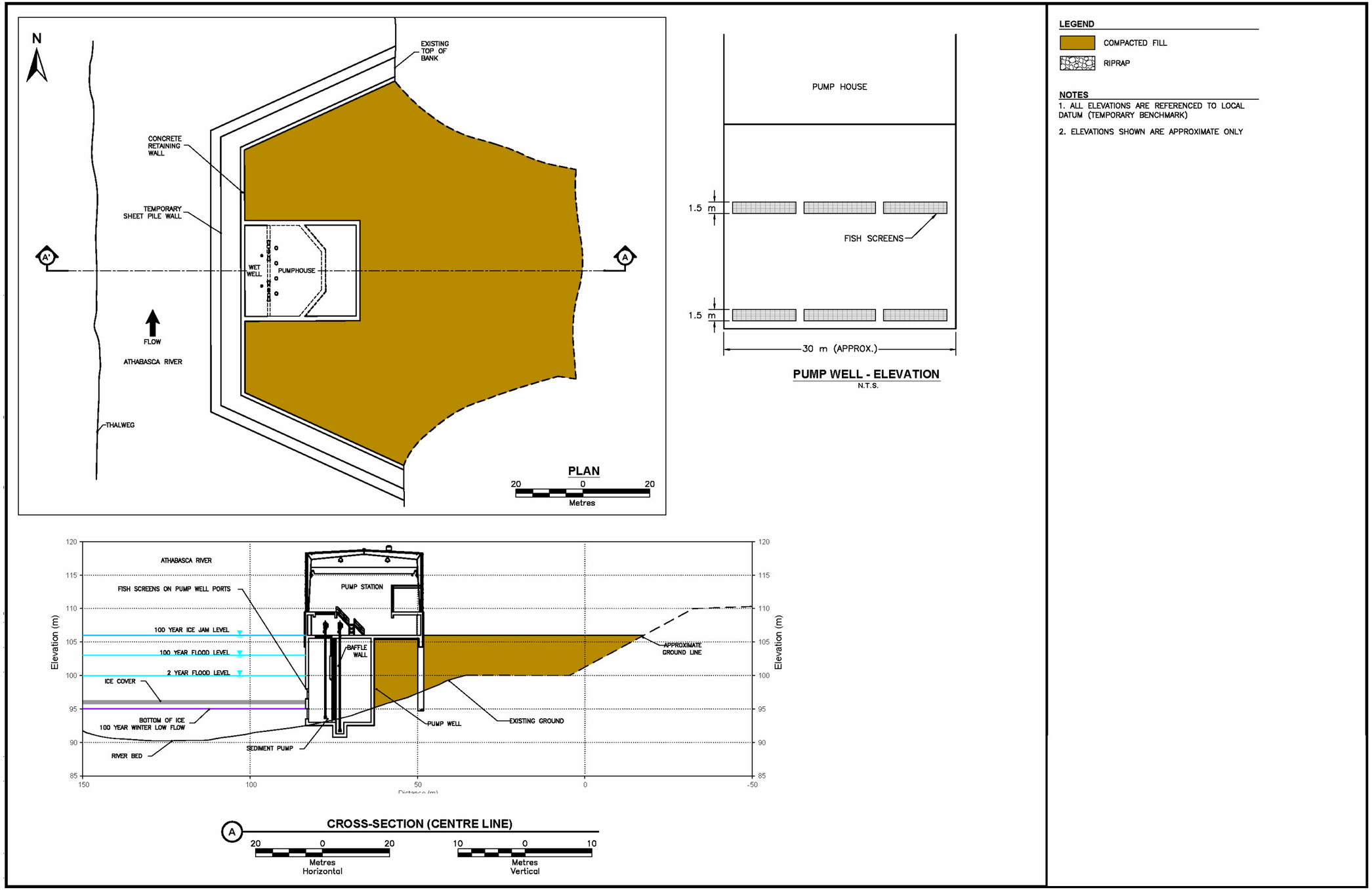


Figure 13-18: Alternative D – Raw Water Intake Design

SCOPE

As indicated in Section 1, Overview, Shell's plan for its oil sands lease holdings has been to develop them through a series of expansions. The expansions can then be scaled and executed in a way that balances the pace of development with execution capability and risk. This measured approach provides the potential for the least cost, highest value development of this substantial resource base through the opportunity to:

- apply the knowledge and efficiencies gained in each expansion of development to the next expansion
- develop and apply new technologies over time

CLOSE-COUPLED DEVELOPMENT APPROACH

In considering alternatives for development, Shell considered delaying the plans for development and increasing the time gaps between potential expansions. This approach was rejected for planning purposes, and the concept of close-coupled expansions is the recommended basis for the application. Close-coupled expansion, in which Shell executes expansions with some level of timing and workforce overlap, provides the best potential for optimizing economic value. Because significant funds have already been invested in Shell's lease holdings, economic value will be destroyed if production and revenue potential are not realized through the earliest possible and most efficient development. The loss of economic value is mitigated by the ability to efficiently advance the developments, which is addressed through the staged close-coupled execution plans.

The staged, close-coupled execution concept used for this application has the specific potential benefits of:

- reducing front-end development engineering costs by providing for a sharing of engineering resources between project components and expansions
- reducing front-end development and detailed engineering costs by allowing for the reuse of engineering designs

CLOSE-COUPLED DEVELOPMENT APPROACH (cont'd)

- providing opportunities for continuity of Shell staff, contractor staff and craft trades to maximize the ability to apply lessons learned and increase efficiency, productivity, and optimize costs and schedule

- providing opportunities for common purchasing of goods and materials between close-coupled project stages

Any other development plan than the one proposed would erode the potential for value to be captured. Therefore, the alternative of delaying or stretching execution was considered and rejected.

PROJECT OBJECTIVES

The Pierre River Mine will be developed and operated to:

- provide safety for the workforce
- protect the environment
- provide high-quality, fit-for-purpose facilities
- be cost competitive
- provide benefits to the local communities

PROJECT MANAGEMENT GOVERNANCE SYSTEM

Overall design and execution of the project will use Shell's integrated Project Management System (iPMS). This governance system takes the project through the various phases of front-end definition, implementation and operations. The iPMS uses a gating philosophy from phase to phase, with clearly defined deliverables and mandatory project practices. A successfully executed iPMS will ensure a high degree of confidence in the key areas of cost, schedule and quality.

External assurance reviews also occur at each gate, to ensure due diligence on the quality of project work and, in particular, on the plan to identify and manage risks in different categories, such as:

- technical
- environmental
- health, safety and sustainable development
- commercial
- organizational
- political

PROJECT PHASES

The project will be executed in five phases:

- development plan
- front-end development
- project implementation
- commissioning and start-up
- operations

Development Plan Phase

Development planning has confirmed the preliminary feasibility, technology selection and project scope. This phase culminated in the approval of conceptual designs that are the basis for this application.

Front-End Development Phase

The Front-End Development Phase provides the design for executing each of the project segments. During this phase, an engineering, procurement and construction management (EPCM) contractor will be selected to work with Shell's project team to:

- further the project development
- provide a smooth transition between pre- and post-investment decision points

Long-lead-time equipment might be procured during this phase to protect costs or maintain the project schedule. The key operations representatives will be appointed and an overall operating philosophy established. Subsequently, start-up and operating strategies will be developed and the operating organizational structure set.

Project Implementation Phase

The Project Implementation Phase is driven by the commissioning and start-up schedule and plans. These plans prioritize construction and construction requirements, which define engineering requirements. During this phase, the operating organization will be finalized, operating systems and procedures will be developed and tested, and staff recruited and trained. The project and operating groups will, in turn, coordinate their activities to execute an effective start-up.

Commissioning and Start-Up Phase

During the Commissioning and Start-Up Phase, a project team will be assembled, consisting of process and discipline engineers who have been involved in the project from conceptual design through to detailed engineering. This team will provide training, start-up planning and support to the operating staff to:

- ensure continuity of knowledge
- obtain operations input into the detailed design
- ensure a smooth transition from construction to operations

Operations Phase

The facilities will be optimized during the first years of the Operations Phase. Any support requirements from the project execution organizations will be identified during the transition from construction to operations.

STAFFING PLAN

Key staff positions for the project will be filled by experienced Shell personnel. The staffing procedure, along with Shell management systems, will ensure that lessons learned from previous project phases are incorporated into the current project and that continuity with key contractors is maintained.

RESPONSIBILITIES

Engineering and Construction

The engineering and construction group will develop the process plant, utilities and offsites, and infrastructure from initial concept through to initial operation. The facilities will then be handed over to the operations group, which will operate and maintain the facilities for the life of the mine.

Mining

The new project mining organization will be responsible for all field mining activity from initial concept to mine closure. This will include planning, engineering, procurement, project development, construction and subsequent operations.

PRELIMINARY SCHEDULE

A preliminary overall schedule for the Pierre River Mine is shown in Figure 14-1. The schedule is based on regulatory approval of the application being received by mid-2009.

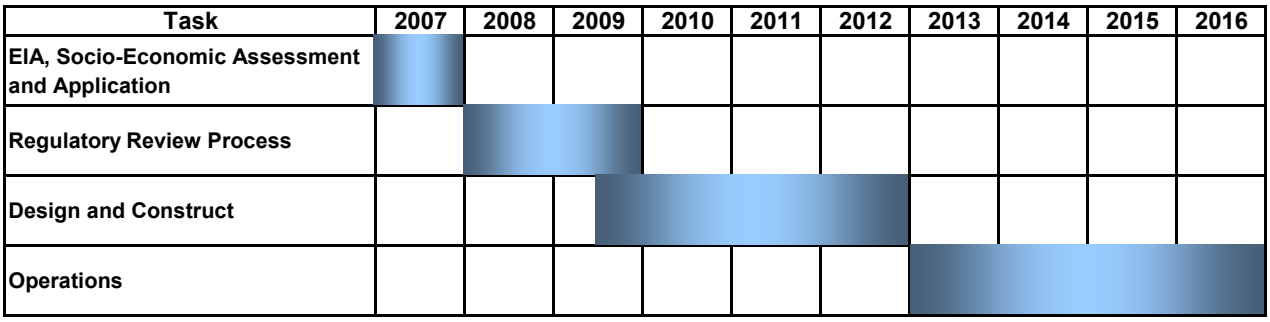


Figure 14-1: Preliminary Schedule for Pierre River Mine

KEY INITIATIVES AND PROJECT STRATEGIES

The Project Execution Plan incorporates key initiatives and strategies that will help ensure project success. These initiatives and strategies include:

- using knowledge gained from the existing Muskeg River Mine and Jackpine Mine – Phase 1

KEY INITIATIVES AND PROJECT STRATEGIES (cont'd)

- adopting best practices and lessons learned from other organizations that have executed recent megaprojects in the oil sands industry
- using a carbon copy of the inside battery limit (ISBL) design of Jackpine Mine – Phase 1 to achieve a high level of detailed design and material availability before construction starts
- executing the work so that the peak craft workforce requirements are reduced and sustained, as far as practicable
- providing a predictable cost outcome for the project's schedule targets
- developing labour strategies to execute the project in a highly competitive and active market. Local labour will be the first choice for providing the required workers during project construction. However, if this pool becomes exhausted, foreign workers will be considered, in some circumstances.
- maximizing off-site construction through modularization
- using an integrated and cross-functional project organization to form an experienced project team that will develop the scope of the project. During the Implementation Phase, the shift to leveraging engineering, procurement and construction management (EPCM) contractors' capabilities will occur.
- involving operations staff early in the project, allowing for a smooth transition from project execution to operations

ENGINEERING, PROCUREMENT AND CONSTRUCTION

Project Execution Team

A project execution team, consisting of experienced engineering and construction members, will be assembled for the Front-End Development Phase. The size of the team will increase as the level of activity increases. The project execution team will manage the activities of the EPCM contractor and have overall responsibility for the project.

EPCM Contractor

Proposals will be requested from qualified companies to engineer, procure and manage the construction of the site facilities. The work will be done during:

- the Front-End Development Phase, which will focus on the project specification and cost estimating
- detailed engineering, procurement and construction of the process facilities and infrastructure. This work will start as soon as the final investment decision has been made.

The EPCM contractor will be responsible for:

- managing the engineering for process and project facilities
- preparing the basic and detailed design
- procuring equipment and materials
- managing the construction health, safety and environment (HSE) program
- managing construction
- managing the quality assurance and quality control program
- planning and scheduling activities
- cost estimating and cost control
- accounting

Specialty work, such as geotechnical and tailings, might be subcontracted to other engineering firms.

Front-End Development Engineering

Front-end development engineering will provide enough process engineering and plant design to support feasibility work and cost estimating. Much of the value improvement process will also be done in this phase. Between 5% and 10% of the total engineering effort will be completed during this phase, including:

- process flow sheets
- material balances
- a water balance
- preliminary process and instrumentation diagrams
- an equipment list
- a plot plan
- a site plan
- a general arrangement of the facilities
- electrical single-line diagrams
- general specifications for each engineering discipline
- major equipment specifications
- sketches of civil, structural, piping and electrical work for estimating

Documentation produced during this phase will include:

- procurement standards
- a contracting plan
- a construction plan
- a detailed project execution schedule
- a detailed operating cost estimate
- a capital cost estimate

Bids will be solicited for major equipment items so that costing can be done. Purchase orders will be released for these items as soon as the final investment decision for the project has been made.

Detailed Engineering

Detailed engineering will begin after the final investment decision has been made. This major effort will require a peak of over 400 engineers and other professionals for about three years. Shell's project team will approve all work and will have team members based in, or near, the EPCM contractor's office.

All detailed engineering will be completed to a level required for successful installation of the facilities. All equipment and materials will be specified to the appropriate standards.

Procurement

Procurement services, provided by the EPCM contractor, will include:

- selecting qualified bidders
- purchasing
- conducting inspections
- materials transportation and handling

An approved vendors' list will be developed early in the project and all equipment and materials will be sourced from reputable suppliers. Final selections will be made based on:

- vendor safety records
- quality offered
- cost
- schedule
- vendor's environmental track record

Because of Fort McMurray's proximity to the mine, small orders for bulk material and services will be preferentially supplied by local companies, provided they are competitive. Shell intends to obtain most other bulk materials from Canadian sources.

Construction

The project will be constructed by a number of contractors selected on the basis of safety, quality, cost, schedule and capability. Only highly qualified and proven contractors will be invited to bid on work. The EPCM contractor will manage these contractors and inspect their work.

Measures to help reduce high on-site labour and on-site transportation costs will include:

- using modularization techniques, and completing as many jobs as possible in the factory

- housing construction workers at the Albian Village camp near the construction site

Pre-Commissioning and Mechanical Completion

A commissioning manager and team from the EPCM contractor's organization will be appointed well before commissioning starts. The selected manager will be experienced in commissioning and will be thoroughly familiar with the processes and equipment used.

The commissioning team will implement a pre-commissioning and commissioning program for each area of the project as construction nears completion. A deficiency list, check-out and start-up sequence will be followed with a system of sign-offs to ensure that every element is carefully checked.

Initially, the process equipment will be checked and commissioned with water. When the entire facility has been run successfully with water and all deficiencies have been corrected, feed will be introduced into the process and each system, module and area will be commissioned.

Plant operations personnel will be involved in each step of the commissioning program to ensure that they are knowledgeable about, and satisfied with, the completed facilities.

PURPOSE

An Operations Implementation Plan (OIP) has been developed for the project. The purpose of the OIP is to provide:

- guidance, direction and standards regarding the role of operations in the project
- a platform for safe and efficient start-up, operation and maintenance of the new facilities

SCOPE

The OIP:

- details the philosophy and approach that operations intends to use for providing effective and timely input to front-end development and detailed engineering
- addresses the plans for commissioning and start-up
- outlines relevant lessons learned in previous projects, so that they can be effectively addressed and implemented
- provides a basis for managing the new facilities
- provides tools to enable timely sourcing of all personnel requirements
- ensures optimal preparation to enable efficient, safe and economical operation of the new facilities
- adopts a structured and proactive approach to managing uncertainty

COMMISSIONING AND START-UP STRATEGY

Generally, the construction team hands over the facilities to the operations team when the facility has been deemed mechanically complete. The operations team is then responsible for planning and implementing the commissioning and start-up activities. The commissioning and start-up team's main activities include:

COMMISSIONING AND START-UP STRATEGY (cont'd)

- conducting health, safety and environment related activities
- defining and monitoring key performance indicators
- identifying activities, planning methods, tools and resources required
- developing a commissioning and start-up plan
- monitoring completion of activities and work hours required
- monitoring the number of systems completed
- developing procedures for commissioning and start-up and for normal operations
- developing and implementing competency programs
- preparing for, and ensuring, adequate handover of responsibility from the project team

The commissioning and start-up team will:

- define the responsibility, accountability, consultation and information requirements of the commissioning and start-up organization
- define and identify project milestones
- identify and provide required personnel

Work execution flow sheets and detailed commissioning and start-up schedules will be developed. These will show the logic, sequence, relationships and timing of all commissioning and start-up activities, as well as overall project integration aspects. Work execution flow sheets and schedules are owned by Shell's commissioning and start-up manager.

OPERATIONS ORGANIZATION AND STAFFING

Organization

An on-site management team will be assigned to the Pierre River Mine. The operations organization is expected to be similar to the previously used management team structures and is shown in Figure 14-2.

Staffing

Shell will identify and provide the project and operations resources required for:

- estimating personnel requirements for all project-related activities
- defining organizational requirements for operations after the project has been completed

The recruiting strategy will include:

- preparing job descriptions, roles and responsibilities
- confirming the availability and competency of existing staff
- setting recruitment targets for specific positions
- developing selection criteria and interview techniques
- developing a recruitment process and employment contracts
- training new personnel

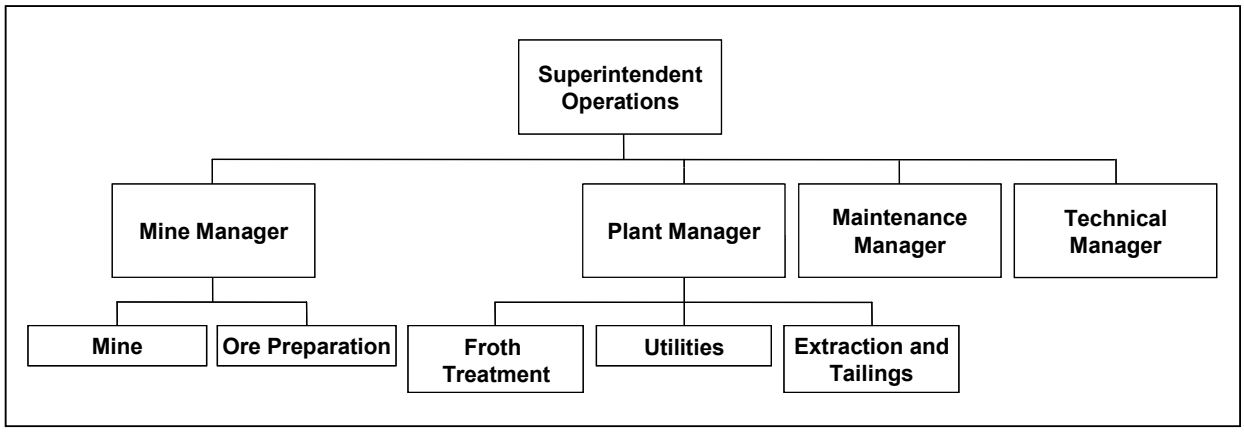


Figure 14-2: Pierre River Mine Operations Organization

SCOPE

The major technology development programs currently active are:

- non-segregating tailings (NST)
- extraction cyclones
- froth treatment
- asphaltene energy recovery

NON-SEGREGATING TAILINGS

A 100 t/h demonstration plant is currently being operated at the Muskeg River Mine site to test the production, transportation and deposition of non-segregating tailings mixtures. This demonstration plant, the culmination of two years of technology development, will provide the data to support the design of commercial NST production facilities. Alternatives to NST production will also be tested to assist in the economic evaluation of tailings management alternatives. The objective is to produce a non-segregating, in-pit deposit that is ultimately reclaimable to satisfy regulatory requirements. For further information, see Section 7, Tailings Management.

EXTRACTION CYCLONES

A 250 t/h extraction cyclone pilot plant is currently being operated at the Muskeg River Mine site to demonstrate the technical viability of extraction cyclones as an alternative to using a PSC for the initial separation of bitumen. This development program has been active since late 2004. The objective is to develop a technology that is capable of maintaining high recoveries of low-grade ores and avoid the need for capacity de-rating of the current technology platform for future expansions.

FROTH TREATMENT

The low-temperature paraffinic froth treatment technology has been successfully demonstrated in the Muskeg River Mine operation. Shell's continued work on technology development, coupled with lessons learned from operations, has led to the improved high-temperature froth treatment design being applied to all subsequent processing trains, including the Jackpine Mine Expansion and the

FROTH TREATMENT (cont'd)

Pierre River Mine. Shell intends to further improve the froth treatment technology to enhance or optimize the level of rejection of asphaltenes, to enable further process simplification and, where applicable, to enable environmental footprint reduction. Shell will also look into ways to improve the processability of the froth-treated bitumen for a wider market as the bitumen production volume grows with future expansions.

ASPHALTENE ENERGY RECOVERY

A number of cogeneration options are being considered for providing the main source of steam and electricity at the Jackpine Mine Expansion. The options include:

- an asphaltene energy recovery (AER) unit with conventional boiler technology
- a natural-gas-fired cogeneration facility

The AER technology is of interest because it makes use of an otherwise waste stream as a source of energy, thereby reducing overall dependence on natural gas as a source of energy for the proposed project. Shell is evaluating further improvements to this technology, such as oxygen firing, that could reduce the overall emissions to the equivalent of gasification with future carbon capture-ready option.

AER will be considered for recovering asphaltenes from the TSRU tailings and using them in a pulverized-fuel-fired cogeneration plant to generate the steam and power required for ore processing.

Shell has been pilot testing the asphaltene recovery circuit, developing an understanding of asphaltene handling, and testing the combustion characteristics of the asphaltene fuel cake, to support the process design. Shell will continue to develop this AER technology for potential application in this project. The future development program will include:

- alternating combustion methods or technologies, such as firing with oxygen instead of air, that could enable higher CO_2 capture
- optimizing the process line-up of the environmental units by using best available technology economically achievable (BATEA) to deliver required performance
- characterizing the potential waste products derived from the AER process, and designing systems to minimize waste and deliver safe, environmentally acceptable methods for disposal

COMMITMENT

Shell is committed to consulting with, and responding to, stakeholders' concerns and interest in the proposed Pierre River Mine. Shell believes that stakeholder involvement improves the sustainability of Shell's decisions and operations.

CONSULTATION PROCESS

Shell's consultation process involves:

- gathering input in consultation with communities, individuals and groups to identify and understand their issues and concerns
- determining what can be done to address concerns and reviewing the outcome of such decisions with stakeholders
- implementing the agreed upon action

CONSULTATION PRINCIPLES

Public consultation for the proposed Pierre River Mine will continue to focus on identifying and resolving concerns and issues in a sustainable manner according to the Consultation Principles (see Figure 15-1).

GOOD NEIGHBOUR POLICY

Based on Shell's consultation principles, the Good Neighbour Policy (see Figure 15-2) is the foundation for a mutually prosperous, long-term relationship with the people living close to Shell's operations.

Consultation Principles

- **Shared Process –** Design consultation programs based on public input, taking into consideration their knowledge, in areas where Shell operates or plans to operate.
- **Respect –** Respect individual values. Consultation recognizes the legitimacy of peoples' concerns and the valuable input they can provide.
- **Timeliness –** Start consultation early. Provide social and environmental information and resources to ensure that the public and regulators are informed when participating in the consultation process. Disclose all relevant information as long as it does not affect Shell's competitive position. Use appropriate methods of communication to proactively provide frequent updates to stakeholders and respond to questions and requests for information in a timely way.
- **Relationships –** Establish and maintain long-term relationships with key stakeholders through interaction, working teams and general involvement in the project. Meet and work with stakeholders face-to-face, whenever possible.
- **Communication –** Consult closely with communities and interested parties affected by the project and regulatory process. Gather and listen to feedback, and work with people to resolve any concerns that might be identified.
- **Responsiveness –** Adapt plans based on stakeholder input and provide feedback on how input has affected plans and decisions. Establish feedback mechanisms to ensure that input is being captured and concerns addressed on an ongoing basis.
- **Accountability –** Trust that representatives of interest groups are accountable to the organizations they represent.

Figure 15-1: Consultation Principles

Good Neighbour Policy

Shell's objective is to develop a mutually prosperous, long-term relationship with our neighbours living in close proximity to our oil sands operations.

We will use the following principles as a guide in developing such a relationship:

- We will earn trust and respect at an early stage through honest, open and proactive communication.
- We will, on an ongoing basis, involve our neighbours in decisions that impact them with the objective of finding solutions that both parties view as positive over the long term.
- We will construct and operate our oil sands operations in an environmentally responsible and economically robust manner.
- We will use and encourage local businesses – where they are competitive and can meet Shell's requirements.
- We will ensure that the jobs created by our oil sands operations are filled by its neighbours whenever possible – but always on a strictly merit basis. To help make this happen, we will as necessary work with our neighbours, contractors, educational institutions and other producers to develop the skills required.

Figure 15-2: Good Neighbour Policy

CONSULTATION GOALS AND OBJECTIVES

The goals of the Pierre River Mine consultation program are to:

- provide neighbours with clear, timely information about the technology, environmental performance, potential impacts and opportunities associated with the Pierre River Mine
- understand the potential issues and concerns of individuals and groups that might be directly affected by the proposed expansion

Through this dialogue process, Shell intends to:

- search actively for win-win results and ways to add value for all parties
- build long-term ownership of, and commitment to, mutually agreed-upon solutions
- strengthen existing relationships and build new ones

CONSULTATION PROCESS

Stakeholder consultation is part of ongoing, long-term business activities associated with the current and future operations. Shell now has a 10-year history of consulting and engaging with stakeholders on project development issues.

An integrated, cross-disciplinary team leads the consultation process. Individual team members are delegated responsibility for maintaining working relationships with assigned groups of stakeholders. The consultation team generally consists of representatives from management, regulatory, environment, community and Aboriginal affairs, technical, land and communications. The consultation team meets regularly to update each other on stakeholder issues, and the consultation progress.

Shell submitted a First Nations' Consultation Plan for the project to Alberta Environment in June 2007. The consultation process with First Nations for the Pierre River Mine is consistent with *Alberta's First Nations Consultation Guidelines on Land Management and Resource Development* (Updated November 14, 2007).

Soliciting Input

Input on the proposed Pierre River Mine is being gathered from communities, individuals and groups, including:

- neighbouring and regional residents
- First Nations and Métis communities and organizations
- special interest groups representing the broader public interest
- government agencies

Providing Information

Information about project plans and activities is being provided through:

- news releases and printed public notices
- a Public Disclosure document
- information posted on Shell's website (www.shell.ca/oilsands)
- a toll-free telephone line (1-800-250-4355)
- open houses

Contact information is included in information updates, including the name, area of responsibility, e-mail address, and telephone and fax numbers for key project staff.

Information Telephone Line

A toll-free telephone number, established in 2002, continues to be a useful feedback mechanism. Questions and requests for information are documented and responded to, and feedback is forwarded to the appropriate staff.

Project E-Mail Address

In 2006, an e-mail address (localcontractorinfo@shell.com) was established to share information on Shell's local and Aboriginal businesses and contracting process. This e-mail address continues to be used to provide answers and to respond to requests for information. Currently, over 450 e-mails have been received from local businesses and over 500 responses have been provided by Shell.

In November 2007, a Pierre River Mine e-mail address (projectinfo@shell.com) was established for the public to ask questions and seek information on the project. Questions received at this e-mail address will be documented and forwarded to the appropriate member of the project team for response.

ISSUES MANAGEMENT PROCESS

Issues management is modelled on the stakeholder engagement process and programs. Issues relating to the Pierre River Mine are identified, assessed and documented, and the appropriate lead or leads from the integrated cross-disciplinary consultation team addresses project-specific issues. Where appropriate, mitigation strategies are developed mutually with communities and groups, using the principles in the Good Neighbour Policy.

ONGOING CONSULTATION

Stakeholder consultation continues to be an integral part of Shell's ongoing business activities.

Shell has reviewed and updated its stakeholder engagement strategy in preparing for the proposed Pierre River Mine to ensure that:

- adequate resources have been allocated
- robust tools and processes are in place
- interests and issues can be clearly identified and assessed

CONSULTATION PROCESS

Stakeholder Input

Shell continues to work with its closest neighbours and actively participates in regional multi-stakeholder groups and initiatives to address regional environmental and socio-economic concerns.

Specific to the Pierre River Mine, Shell has gathered, and will continue to gather, input from communities, individuals and groups, including:

- neighbouring and regional residents
- First Nations and Métis communities and organizations
- special interest groups representing the broader public interest
- industry neighbours
- government agencies

Stakeholder Dialogue

Dialogue has occurred in various ways, including:

- meetings of:
  - individual stakeholders
  - multi-stakeholder groups and committees
- workshops and forums
- community open houses

Stakeholder Dialogue (cont'd)

In support of this dialogue, Shell has provided information about its plans and activities through:

- advertisements and public notices
- news releases
- speaking engagements and audio-visual presentations, on request
- public disclosures
- public documents posted on Shell's website, such as:
  - the Public Disclosure
  - the Proposed EIA Terms of Reference
- a toll-free telephone line (1-800-250-4355)
- information handouts

Feedback

Feedback mechanisms are used to provide the public with an opportunity to:

- ask questions
- voice concerns
- provide comments and suggestions

Telephone

A toll-free telephone number has been established. The script was updated before both the Public Disclosure and the EIA Proposed Terms of Reference were distributed. The number was listed in all advertising and information updates, including:

- regulatory documents
- open house information packages
- promotional items

Between January 2007 and October 2007, about 24 enquiries related to the proposed project were received:

- nine general enquiries about the project
- 15 enquiries about project employment

E-Mail

Contact information is included in all advertisements and information updates, including a list of key contact personnel that includes:

- name
- area of responsibility
- telephone and fax number
- e-mail address

Shell staff respond to enquiries as they are received.

STAKEHOLDER IDENTIFICATION

The stakeholder engagement program for the proposed Pierre River Mine is a continuation of the program already in place for Shell's current mining operations. This program includes evaluating and reconfirming individuals and groups that would be directly affected by, or demonstrate an interest in, plans for the proposed Pierre River Mine, including:

- local communities
- First Nations and Métis leaders and organizations
- trappers
- regional environmental non-government organizations
- regional non-government organizations
- Regional Municipality of Wood Buffalo (RMWB)
- federal government departments
- provincial government departments
- industry representatives

Local Communities

The local communities include:

- Fort Chipewyan
- Fort McKay
- Fort McMurray

First Nations and Métis Leaders and Organizations

The First Nations and Métis leaders and organizations include:

- Athabasca Tribal Council and its member nations, including:
  - Fort McKay First Nation
  - Athabasca Chipewyan First Nation
  - Mikisew Cree First Nation
  - Fort McMurray #468 First Nation
  - Chipewyan Prairie First Nation
- Métis Nation of Alberta – Zone 1, including:
  - Métis Local 125
  - Métis Local 192
  - Métis Local 2020
  - Métis Local 63
  - Métis Local 1935
  - Métis Local 214
  - Métis Local 780

Trappers

The trappers include:

- TPA 1275
- TPA 2939

Regional Environmental Non-Government Organizations

The regional environmental non-government organizations include:

- Oil Sands Environmental Coalition (OSEC)
- Cumulative Environmental Management Association (CEMA)
- Fort McMurray Environmental Association

Regional Non-Government Organizations

The regional non-government organizations include:

- Fort McMurray Catholic School Board
- Fort McMurray Public School Board
- Northlands School Division
- Keyano College
- Keyano College Foundation
- Fort McMurray Chamber of Commerce
- Fort McMurray Construction Association
- Northeastern Alberta Aboriginal Business Association
- Northern Lights Regional Health Services
- Northern Lights Regional Health Foundation
- Nunee Health Authority
- Alberta Aboriginal Apprenticeship Project

Regional Municipality of Wood Buffalo

The Regional Municipality of Wood Buffalo stakeholders include:

- the mayor and council
- RMWB administration

Federal Government Departments

Federal government departments include:

- Canadian Environmental Assessment Agency
- Environment Canada
- Fisheries and Oceans Canada
- Indian and Northern Affairs Canada
- Transport Canada

Provincial Government Departments

Provincial government departments include:

- Alberta Energy
- Alberta Energy and Utilities Board
- Alberta Environment
- Alberta Health and Wellness
- Alberta Sustainable Resource Development
- Alberta Infrastructure and Transportation
- Alberta International, Intergovernmental and Aboriginal Relations

Industry Representatives

Other companies interested in the developments include:

- Alberta-Pacific Forest Industries Inc.
- Birch Mountain Resources Ltd.
- Canadian Natural Resources Limited
- ExxonMobil and Imperial Oil Resources
- Suncor Energy Inc.
- Syncrude Canada Ltd.
- Northland Forest Products Ltd.
- UTS Energy Inc.
- Petro-Canada
- Total E&P Canada Ltd.
- Synenco Energy Inc.
- Husky Oil Ltd.

STAKEHOLDER CONSULTATION

Shell continues to work with its closest neighbouring communities and to actively participate in regional multi-stakeholder groups and initiatives to address environmental and socio-economic concerns. Shell seeks permission from Aboriginal communities and organizations to access their community information to be used in project planning, including the environmental impact assessment. To date, Shell has requested and received permission to use specific community information and written reports from:

- Athabasca Chipewyan First Nation
- Fort McKay First Nation
- Fort McMurray #468 First Nation
- trappers

Shell is also working with First Nation communities in documenting information on their traditional land use and traditional ecological knowledge as it relates to the project. These studies are currently in progress and the results will be provided later as an update to the Environmental Impact Assessment.

Fort McKay

Since 1997, Shell has established a strong relationship of effective consultation with the community of Fort McKay and its Industry Relations Corporation (IRC). This generated two early principle-based agreements that cover the community's key concerns about environmental and socio-economic issues, and a subsequent addendum specific to the Jackpine Mine Expansion. These agreements and addenda resulted in project-specific environmental and socio-economic commitments to Fort McKay from Shell.

Each year, Shell and the Fort McKay IRC develop annual action plans, which are regularly reviewed to measure progress against commitments. The key issues that have been identified by the community of Fort McKay that Shell is addressing through continuous improvement and seeking more sustainable solutions for, include:

- incorporating traditional environmental knowledge into project development and operating plans
- establishing projects and programs that support the retention of traditional culture
- enhancing community infrastructure

In 2007, Shell began meeting and developing a relationship with Fort McKay Métis Nation Local 63, now separate from the Fort McKay IRC. Shell is currently engaged in discussions with this group to better understand their issues.

On October 31, 2007, Shell and Métis Nation Local 63 signed a Good Neighbour Agreement. This agreement sets out Shell's and Métis Nation Local 63's intention to share information and work together in the spirit of cooperation and mutual respect.

Fort Chipewyan

Since 2001, Shell has been working to establish a relationship of effective consultation with the community of Fort Chipewyan, including the:

- Athabasca Chipewyan First Nation and its IRC
- Mikisew Cree First Nation and its IRC
- Métis Local 125

This has resulted in agreements with each First Nation, and subsequent project-specific environmental and socio-economic commitments from Shell to the Athabasca Chipewyan First Nation. Each year action plans are developed, which are reviewed regularly to measure progress against commitments. The key issues that have been identified by the community of Fort Chipewyan, that Shell is addressing through continuous improvement and is seeking more sustainable solutions for, include:

- reclamation
- water management
- opportunities for local Aboriginal businesses
- employment opportunities for local community members

Fort McMurray

Since 1997, Shell has provided the Regional Municipality of Wood Buffalo with information about its:

- development projects
- workforce plans
- construction schedules and plans
- detailed socio-economic impact assessment information

Shell representatives continue to meet with the planning department staff to provide project-specific planning information, understand issues and discuss opportunities and options to offset project-specific socio-economic impacts on the Fort McMurray community.

Shell representatives sit on the boards of directors of the Northern Lights Regional Health Foundation and Keyano College to ensure that these not-for-profit regional organizations have up-to-date accurate planning information on all proposed development projects.

On May 29, 2007, Shell, through the AOSP operating company, Albian Sands signed a Memorandum of Understanding (MOU) with the Northern Lights Health Region (NLHR). Shell is committed to installing an on-site medical centre for the Muskeg River Mine Expansion, and Jackpine Mine – Phase 1 projects, which will also serve the Jackpine Mine Expansion. This centre will be staffed with health professionals to support people working and staying on site. The centre will provide primary care, and manage minor health issues and injury incidents without drawing on the services of the NLHR. A similar facility might be constructed at the Pierre River Mine. The key drivers behind these facilities are health and safety considerations. The MOU further supports, in principle, working together to explore opportunities for joint collaboration on a proposed Return in Service (RIS) program for health care professionals. The RIS program would provide bursaries to health care students to offset their cost of tuition, with a corresponding obligation to commit to working in the region for a dedicated period.

Shell has a relationship with Métis Local 1935 based on a Good Neighbour Relationship Agreement signed in November 2006 and a subsequent annual action plan in 2007.

Shell continues to play a strong role on various regional and industry planning associations and groups, including the:

- Cumulative Environmental Management Association (CEMA) and its working groups

Fort McMurray (cont'd)

- Regional Issues Working Group (RIWG) and its various committees
- Athabasca Tribal Council (ATC) working committees
- Fort McMurray Chamber of Commerce
- Northeastern Alberta Aboriginal Business Association (NAABA)
- Community Careers Cooperative
- Wood Buffalo Community Futures
- Wood Buffalo Environmental Association (WBEA)
- Mining Association of Canada (MAC)

Regulators

A meeting involving participants from both federal and provincial regulatory agencies was held on May 10, 2007, to discuss the Pierre River Mine. This meeting included sharing information about and discussing:

- the EIA overview
- the project description
- potential socio-economic issues
- potential environmental issues
- environmental assessment methods

MULTI-STAKEHOLDER GROUPS

Multi-stakeholder groups include the:

- Athabasca Tribal Council and Athabasca Resource Development
- Cumulative Environmental Management Association
- Regional Issues Working Group
- Alberta Aboriginal Apprenticeship Project
- Aboriginal Human Resources Council
- Oil Sands Environmental Coalition

Athabasca Tribal Council and Athabasca Resource Development

Shell is a signatory to the Athabasca Tribal Council All-Parties Core Agreement and participates on both the working group and management committee. Shell will also participate in the Long-Term Benefits Agreement, the successor agreement to the All-Parties Core Agreement that is currently being negotiated.

Shell participates on the following standing policy and operating committees of the ATC:

- the executive group
- the physical infrastructure subcommittee
- the jobs, education and training subcommittee
- the ATC All-Parties Agreement re-design team

Cumulative Environmental Management Association

Shell was one of the founding members of the organization now called CEMA and continues to actively lead or participate on all CEMA working or task groups. CEMA is a multi-stakeholder consensus-based regional advisory body that includes representatives from:

- Aboriginal groups
- environmental groups
- governments
- the Regional Municipality of Wood Buffalo
- health authorities
- oil sands companies and other resource developers

CEMA's mandate is to make recommendations to government and industry on regional environmental issues related to resource development and use, using the regional sustainable development strategy (RSDS) as a working framework. The current focus is on recommending the regional environmental carrying capacity for:

- water
- air
- terrestrial and aquatic ecosystems

Regional Issues Working Group

Shell has been an active participant in the RIWG since it was formed in 1997. The RIWG consists of representatives from:

- the municipal government
- the provincial government
- oil sands developers in the Wood Buffalo region

The mandate of the RIWG is to:

- identify current issues affecting the region
- collect baseline data for long-term planning purposes
- develop advocacy strategies to address these issues

Shell participates on the following committees and subcommittees of the RIWG:

- Aboriginal affairs
- child care
- cogeneration
- education and jobs
- east side corridor and transportation
- health services

Alberta Aboriginal Apprenticeship Project

Shell has been a member of the Alberta Aboriginal Apprenticeship Project (AAAP) since 2005, to increase the number of Aboriginal tradespeople at the Muskeg River Mine, the Jackpine Mine Expansion and, eventually, the Pierre River Mine.

Shell participates on the following AAAP subcommittees:

- the Operational Steering Committee
- the Alberta Aboriginal Apprenticeship Committee
- the Transition Committee

Aboriginal Human Resources Council

Since 2005, Shell has been a member of the Aboriginal Human Resources Council (AHRC). The AHRC provides national, leading expertise in Aboriginal recruitment, retention and advancement. The AHRC has developed numerous programs in which Shell participates, including:

- Guiding Circles
- Mastering Inclusion Network
- Trades and Apprenticeship
- Workforce Connex

Shell also participates on the following subcommittees of the AHRC:

- Networks of Change
- National Aboriginal Trades Committee
- Champions Committee

Oil Sands Environmental Coalition

The Oil Sands Environmental Coalition (OSEC) represents the following groups:

- Pembina Institute
- Toxics Watch Society of Alberta
- Fort McMurray Environmental Association

Shell has a working relationship with OSEC based on an Issue Resolution Document for the Jackpine Mine – Phase 1, dated July 2003, and a subsequent Issue Resolution Document for the Muskeg River Mine Expansion Project, dated August 2006.

Since the proposed Pierre River Mine was publicly disclosed, Shell has met with OSEC representatives several times to outline the proposed expansion and identify issues.

PROJECT-SPECIFIC CONSULTATION

Public Disclosure

On January 25, 2007, the Pierre River Mine was publicly disclosed. The Public Disclosure document was mailed to about 470 stakeholders in the Regional Municipality of Wood Buffalo and to federal and provincial regulators. Shell also provided copies of the Public Disclosure document to the First Nations identified in the First Nations Consultation Plan for the project. The document was made available to the general public on Shell's website. A project-related toll-free telephone number was advertised for those seeking additional information or follow-up. Copies of the Public Disclosure were made available in the following centres:

- Albian Sands community office
- Fort Chipewyan Municipal Contact Office
- Fort McKay Industry Relations Corporation
- Fort McMurray Public Library
- Oil Sands Discovery Centre
- Alberta Environment Register of Environmental Assessment Information

Copies of the Public Disclosure document continue to be provided, upon request.

EIA PROPOSED TERMS OF REFERENCE

On July 12, 2007, copies of the Proposed Terms of Reference for the EIA were distributed to key interested stakeholder groups, including the:

- Fort McKay First Nation
- Athabasca Chipewyan First Nation
- Mikisew Cree First Nation
- Fort McMurray #468 First Nation

In addition, the availability of the Proposed Terms of Reference for the EIA was advertised in newspapers, and the public was invited to comment. Between July 17 and 19, 2007, advertisements were placed in the:

- *Calgary Herald*
- *Calgary Sun*
- *Edmonton Journal*

EIA PROPOSED TERMS OF REFERENCE (cont'd)

- *Edmonton Sun*
- *Fort McMurray Today*

This document was also made available on Shell's website. A toll-free telephone number was advertised for those seeking additional information or follow-up.

EIA FINAL TERMS OF REFERENCE

The Final Terms of Reference were issued by Alberta Environment on November 28, 2007.

STAKEHOLDER MEETINGS:

Stakeholder issues have been identified through:

- early consultation
- the April 25, 2007, meeting with multiple key stakeholders, including Fort McKay First Nation, Athabasca Chipewyan First Nation, Mikisew Cree First Nation and OSEC, to review approaches, methodologies and potential issues for the EIA and SEIA
- an ongoing, well-established relationship with stakeholders

Meetings have also been held with Fort McMurray #468 First Nation IRC, Métis Local 63 and Métis Local 1935, to provide project updates, discuss issues and, where appropriate, develop plans for future activities. Efforts are ongoing to meet with Métis Local 125 to provide project updates.

Fort McKay

On September 11, 2007, Shell held two consecutive open houses in the Fort McKay community. A luncheon, project presentation and discussion were held specifically for Elders, followed by a similar evening session open to all community members. Handout booklets with detailed information were available for everyone to take away and read. Knowledgeable staff and speakers were available to provide additional information, answer questions and discuss issues.

Fort Chipewyan

Since the proposed Pierre River Mine was publicly disclosed, Shell has met and communicated several times with both the Athabasca Chipewyan First Nation and the Mikisew Cree First Nation IRC to outline the proposed project, discuss the EIA and SEIA approaches and methodologies, and identify their joint and individual issues.

On September 19, 2007, Shell held two open houses in the community. A luncheon, project presentation and discussion were held for the Athabasca

Chipewyan First Nation advisory committee members. Later in the afternoon, Shell made a project presentation that was open to all community members, including members of the Mikisew Cree First Nation and Métis Local 125. Handout booklets with detailed information were available for community members to take away and read. Knowledgeable staff and speakers were available to provide additional information, answer questions and discuss issues.

Fort McMurray

On September 12, 2007, Shell held a public open house at the Oil Sands Discovery Centre in Fort McMurray to present project plans and information. This included two sequential project presentations and open discussion periods where individuals asked questions. Detailed information, maps and displays illustrated project plans. Booklets with detailed information were available for visitors to take away and read. Knowledgeable staff and speakers were available to provide additional information, answer questions and discuss issues.

Industry

Shell representatives continue to meet with other industry stakeholders to discuss issues of mutual interest, such as:

- boundary issues
- resource and infrastructure sharing issues
- commercial and technology issues

Ongoing Plans

Shell plans to continue building sustainable relationships with all of its key directly-affected neighbours in the Wood Buffalo region. Issues identified through ongoing consultation, using well-established mechanisms, will continue to be addressed based on Shell's commitment to:

- take direct responsibility for those areas that are directly under its control
- facilitate and advocate for areas that are not under its control
- provide resources for identifying and managing project impacts, where appropriate

STAKEHOLDER CONSULTATION ACTIVITIES

A new format for collecting stakeholder information was developed by Alberta Environment and was instituted by Shell in June 2007. Shell's consultation activities are shown in:

- Table 15-1, which describes the consultation activities from November 2006 to June 28, 2007, using the old format
- Table 15-2, which describes the consultation activities from June 28 to November 2007 using the new format

Table 15-1: Public Consultation Activities – November 2006 to June 2007

Date	Activity	Stakeholder
2006		
November		
8	Visited the trapper's cabin to discuss the winter drilling program for Asphalt Creek. Delivered a cheque for the 2006–2007 winter drilling program.	Trapper 1275
9	Met to discuss the winter drilling programs. The ACFN IRC Environmental Coordinator failed to attend.	Trapper 1714
9	Delivered a gift and conveyed thanks for previous hospitality.	Fort McKay Elders Centre
9	Discussed the need to meet with IRC to discuss the 2006–2007 winter drilling and seismic programs, which do not affect any CPDFN traditional land use areas.	CPDFN IRC
11	Visited home to discuss the rollback on the trapline of a 2–3 m area from any existing trail protected from rollback. Delivered a cheque for the 2006–2007 winter drilling program.	Trapper 1716
11	Visited home to deliver a cheque for the 2006–2007 winter drilling program.	Trapper 2137
11	Visited home to deliver a cheque for the 2006–2007 winter drilling program. The trapper identified and recommended alternative access.	Trapper 2939
11	Visited home to deliver a cheque for the 2006–2007 winter drilling program. Also delivered a cheque for Access Road LOC 062230.	Trapper 1714
11	Visited home to discuss the Jackpine Mine mineral surface lease amendment approval. Also discussed the payment for the 2006–2007 winter drilling program. The trapper requested one cheque. Also notified the trapper that Shell was planning an airstrip on their TPA area that would not be under the amended mineral surface lease.	Trapper 2172
15	Requested a worksheet outlining the amount and type of winter drilling work and compensation paid to affected trappers.	Fort McKay IRC – Environmental Coordinator
22	Toured a beaver site close to the SH07-1625 well. The trapper agreed to start trapping by November 25, 2006.	Trapper 2172
27	Confirmed by e-mail the consultation schedule for industry to present its winter drilling programs to the Elders and the general membership on January 24, 2007.	MCFN IRC – Regulatory Affairs Coordinator
30	Met to discuss the cabin listed on Listing of Significant Historical Sites and Areas. The trapper had no recollection of the cabin being there. Fort McKay IRC staff also had no recollection of the cabin.	Trapper 2172
December		
2	Followed up a telephone conversation by e-mail regarding beaver concerns. Requested the trapper remove the beavers and otters at the red-flag site close to the SH07-1625 well.	Trapper 1716
2	Followed up with an e-mail to core hole questions.	ACFN IRC – Environmental Coordinator

Table 15-1: Public Consultation Activities – November 2006 to June 2007 (cont'd)

Date	Activity	Stakeholder
2007		
January		
09	Discussed by telephone the upcoming national DFO workshop on instream flow needs related to oil sands and the possible participants. Discussed the Muskeg River Mine Expansion Panel recommendations and the need for better communications between the DFO and industry.	DFO
09	Confirmed by e-mail the submission requirements for the Jackpine Mine Expansion Wildlife Habitat Enhancement Plan.	AENV
16	Received a telephone call to inform of address change.	Trapper 2172
24	Made a presentation to the Elders and the general membership on the proposed 2006–2007 winter drilling and seismic program.	MCFN – Fort Chipewyan
24	Issued a news release updating the mine plans for the Jackpine Mine Expansion and the Pierre River Mine.	All
24	Telephoned key stakeholders and alerted them to the news release and to the pending distribution of the Public Disclosure.	About 25 stakeholders
25	Distributed the Public Disclosure, which describes the plans for the Jackpine Mine Expansion and the Pierre River Mine.	All
25	Telephoned to discuss the Public Disclosure document being released and when they would receive a copy.	• ACFN IRC • ACFN Chief • MCFN IRC • MCFN Chief • Métis Zone 1 • Métis Local #1935 • Fort McMurray FN #468 • Fort McKay FN • Métis Local #63 • Chamber of Commerce • NAABA
25	Met to provide an update on the current Public Disclosure. Reviewed the footprint of the proposed project and the potential for harmful alteration and destruction of fish habitat. Also discussed fish habitat issues related to other projects.	DFO
26	Provided an update on the recently distributed Public Disclosure.	MCFN IRC
31	Provided an update on the recently distributed Public Disclosure.	OSEC
February		
05	Provided an update on the recently distributed Public Disclosure.	Fort McKay IRC
27	Met to provide an update on the recently distributed Public Disclosure.	ACFN IRC
27	Met to discuss future business opportunities and contracts for the Jackpine Mine and the Pierre River Mine.	FM Group of Companies

Table 15-1: Public Consultation Activities – November 2006 to June 2007 (cont'd)

Date	Activity	Stakeholder
March		
12	Met to strengthen the relationship and discuss Syncrude's concern about Aurora South, i.e., DFO compensation, attributed to Shell, and to clarify.	Syncrude Canada
14	Met to provide an update on the recently distributed Public Disclosure.	Fort McKay IRC
22	Met to discuss and provide copies of the Public Disclosure.	Local Métis # 1935
22	Met to discuss and provide copies of the Public Disclosure.	FM FN
23	Met to discuss and provide copies of the Public Disclosure. Also discussed future business contracting.	ACFN IRC
April		
03	Met to discuss the Jackpine Mine Expansion and the alignment of operational and closure landscapes and drainages. Shell's proposed plans would require modification of the existing approved Imperial Kearl Oil Sands Project and Syncrude's Aurora South Project plans. The meeting sought alignment on plans, further understanding and a risk analysis.	• Syncrude • Imperial
03	Discussed with local business possible future project contracts and provided schedules.	Local business
05	Sent 12 letters to developers with the request to confirm disturbance areas, air emissions and water withdrawals for each project.	• Birch Mountain – responded • CNRL In Situ – responded • CNRL Mining – Did not respond • Husky – Did not respond • Imperial – Did not respond • Opti/Nexen – Did not respond • Petro-Canada – responded • Suncor – responded • Syncrude – Did not respond • Synenco – responded • Total – responded • UTS Energy – Did not respond
10	Met to discuss active cabins in the TPA area. Confirmed two active cabins. Permission was granted to have noise receptors placed at the cabins for a baseline noise study.	TPA 1716
10	Met to discuss active cabins in the TPA area. Confirmed three active cabins. Permission was granted to have noise receptors placed at the cabins for a baseline noise study.	TPA 2137
11	Held a commitment update meeting and discussed the proposed Jackpine Mine Expansion and Pierre River Mine projects. The Proposed Terms of Reference are pending and input will be sought regarding the SEIA.	ACFN IRC
12	Held a commitment update meeting and discussed the recently distributed Public Disclosure (additional copies provided) for the Jackpine Mine Expansion and the Pierre River Mine. The Proposed Terms of Reference are pending.	MCFN IRC

Table 15-1: Public Consultation Activities – November 2006 to June 2007 (cont'd)

Date	Activity	Stakeholder
April (cont'd)		
12	Met to discuss the active cabins in the TPA area. Confirmed one active cabin. Permission was granted to have noise receptors placed at the cabin for a baseline noise study.	TPA 1275
16	Received a telephone enquiry regarding the possible Shell and Albian Sands involvement in the proposed gathering at Cree Burn Lake site in July with Acho Dene Koe.	Representative of Wood Buffalo First Nation
18	Met to discuss the active cabins in the TPA area. Confirmed two active cabins. Permission was granted to have noise receptors placed at the cabins for a baseline noise study.	TPA 1714
24	Met to provide an update on the recently distributed Public Disclosure and to discuss the consultation approach.	Fort McMurray First Nation #468 IRC
24	Discussed the TOR schedule and Public Disclosure.	Fort McMurray FN #468
25	Held a multi-stakeholder meeting to review the approaches and methodologies for the EIA and SEIA and identify early issues.	• Fort McKay IRC • ACFN IRC • MCFN IRC • OSEC
27	Met with the Chief to discuss community housing ideas and upcoming events.	FMFN
May		
08	Discussed the TOR schedule and local business contracting opportunities for the projects.	Métis Nation Zone #1
09	Provided an update of Shell's local business procedures and contacts presentation at the general meeting.	NAABA
09	Held a teleconference to introduce the SEIA coordinator and provide an update on expansion plans. Also enquired about consultation expectations and identified early issues for technical changes and business planning and labour force mobilization.	RMWB Planning and Development Department
09	Met to discuss the traditional land use study interview conducted by Golder. Requested a fly-over of the trapline to inspect the results of the winter drilling program. Also discussed other related matters.	• TPA 2939 • TPA 1714
09	Viewed the traplines from a helicopter and looked for future cabin locations as a follow-up from the Jackpine Mine commitment to provide and site a replacement cabin. Also discussed and flew over the re-routing of Canterra Road and the planned intersite utility corridor.	• TPA 2172 • TPA 2006
10	Met to discuss the findings from the helicopter flight and possible cabin locations.	• TPA 2172
10	Met with regulators to outline the Jackpine Mine Expansion and the Pierre River Mine Project pertaining to: • EIA overview • project description • socio-economics • potential areas of environmental concern • environmental assessment methods	• EUB • AENV • Justice • ASRD • ATPRC • CEAA • EC

Table 15-1: Public Consultation Activities – November 2006 to June 2007 (cont'd)

Date	Activity	Stakeholder
May (cont'd)		
10 (cont'd)		• DFO • INAC • Health Canada • NRCan • Parks Canada
10	Met to discuss the traditional land use study interview conducted by Golder. Requested a fly-over of the trapline to inspect the results of the winter drilling program. Also discussed other related matters.	TPA 1275
11	Met to discuss the traditional land use study interview conducted by Golder. Requested a fly-over of the trapline to inspect the results of the winter drilling program. Also discussed other related matters.	• TPA 1716 • TPA 2137
11	Met with the Chief over dinner to discuss the previously discussed (see April 27) housing ideas, Shell's expansion projects and accommodation needs.	FMFN
11	Met with the general manager to introduce the SEIA coordinator, review the SEIA assessment methodology and identify key issues. Local 1935 requested increased involvement in TEK and TLU studies, environmental monitoring and business development.	Métis Local 1935
12	Held a courtesy follow-up meeting, from the 2006–2007 winter drilling program, to provide the finalization report submitted to ASRD for the winter drilling program, including the final map and access roads used.	ACFN
12	Met to discuss the traditional land use study interview conducted by Golder.	TPA 2331
23	Scheduled a meeting to scout beaver dams on Khahago Creek to pre-plan for beaver removal for expansion work at the Muskeg River Mine Expansion and the Jackpine Mine. The meeting was postponed until September.	TPA 2172
29	Attended the Memorandum of Understanding signing ceremony. Indicated that Shell and Albian Sands are prepared to financially support a Return in Service (RIS) program.	Northern Lights Regional Health Foundation
31	Dropped in to Albian Sands' Fort McMurray office to express concern over traffic around traplines and bear traps.	Licensed outfitter
June		
04	Received a telephone call regarding the Jackpine Mine and Pierre River Mine. A meeting will be arranged to discuss the project in person.	Fort McMurray FN #468 IRC
06	Met to discuss, and provide a copy of, the Jackpine Mine and Pierre River Mine Public Disclosure. Also discussed the winter drilling program and provided contact information.	Akita Drilling
07	Held a local contracts award event for the Jackpine Mine – Phase 1. Discussed contracting opportunities with local business for the Jackpine Mine and the Pierre River Mine. Distributed the Public Disclosure document.	• Chamber of Commerce • NAABA • Local business
19	Visited home to discuss the Jackpine Mine Winter Drilling Program report submitted to the ASRD. Also provided a first aid kit to support the Forest Watch Program.	TPA 2137

Table 15-1: Public Consultation Activities – November 2006 to June 2007 (cont'd)

Date	Activity	Stakeholder
June (cont'd)		
19	Visited home to discuss the Jackpine Mine Winter Drilling Program report submitted to the ASRD. Also provided a first aid kit to support the Forest Watch Program.	TPA 1716
19	Visited home to discuss the Jackpine Mine Winter Drilling Program report submitted to ASRD. Also provided a first-aid kit to support the Forest Watch Program.	TPA 1714
20	Held an update meeting to review progress on the environmental and socio-economic commitments, as well as provide an update on the proposed Jackpine Mine Expansion and Pierre River Mine.	ACFN IRC
20	Met to discuss the Jackpine Mine and Pierre River Mine. Provided another copy of the Public Disclosure and the schedule.	Fort McMurray FN #468 IRC
20	Responded by e-mail to the legal council's request for information on the beaver removal compensation structure used in 2006.	FM IRC
21	Met to discuss the following dispositions: • LOC 5732 Canterra Road • ESE 070081 (power line within Intersite Utility Corridor) • PLA 071362 (pipeline within Intersite Utility Corridor) ACFN expressed concerns about the ASRD-required consultation process.	ACFN IRC
21	Visited home to discuss concern related to helicopter flights over their residence. Determined that more communication with the stakeholder is necessary to inform him of planned survey work on his trapline.	TPA 1275
21	Visited home to discuss the Asphalt Creek Winter Drilling Program report submitted to ASRD. Also provided two emergency first aid kits to support the Forest Watch Program.	TPA 1716
28	Met to review the addendum to the MOU related to the Jackpine Mine Expansion and the Pierre River Mine projects and the Pre-EIA Identification of Issues.	OSEC
28	Discussed by telephone the FN Lease land area and Jackpine Mine and Pierre River Mine schedules.	FM FN
28	Received an e-mail request for a meeting to discuss the following dispositions: • LOC 5732 Canterra Road • ESE 070081 (power line within Intersite Utility Corridor) • PLA 071362 (pipeline within Intersite Utility Corridor)	MCFN IRC

Table 15-2: Public Consultation Activities – June 28 to November 2007

Date	Stakeholder	Method of Contact	Summary of Issues Discussed	Outstanding Issues and Items for Follow-Up
June				

28	7OSEC	Meeting	• Presented pre-EIA work at the meeting on the following issues:
			  • restoration versus reclamation
			  • risk of irreversible damage to unique ecosystems and riparian habitat
			  • air – BATEA and offsets
			  • Muskeg River watershed
			  • wetlands policy
			  • Athabasca River withdrawal
			  • greenhouse gases
				• Discuss, post-EIA, seven identified issues
				• Follow-up on tailings management. A training session will be provided.

July				
11	ACFN IRC AC	Meeting	• Discussed the Jackpine Mine and the Pierre River Mine • Distributed the Public Disclosure document	None

12	AENV	Telephone call followed by a letter	• Received authorization to proceed regarding:
			  • Proposed Terms of Reference
			  • Aboriginal Consultation Plan and Communication Plan
			  • Public Notice
				None

12	• Fort McKay IRC • ACFN IRC • MCFN IRC • Fort McMurray #468 FN IRC • OSEC	E-mail followed by a telephone call	• E-mailed the Proposed Terms of Reference, Public Notice to key stakeholder groups	None
12	TPA 1275	Home visit	• Placed a noise receptor at the cabin • Responded to questions about the purpose of the baseline study	

Table 15-2: Public Consultation Activities – June 28 to November 2007 (cont'd)

Date	Stakeholder	Method of Contact	Summary of Issues Discussed	Outstanding Issues and Items for Follow-Up
July				
13	BC Hydro (Industry)	Telephone	• Discussed the Jackpine Mine and the Pierre River Mine Public Disclosure • Provided the Jackpine Mine and the Pierre River Mine schedule	None
13	TPA 1275	Home visit	• Gathered the noise receptor from the cabin • Discussed the vegetation survey to begin July 16, 2007. The stakeholder asked to be notified when the survey starts. • Discussed Canadian Helicopters' complaint against the stakeholder	Requested that Golder give the stakeholder notice when the vegetation survey starts.
17	Alberta Aboriginal Apprenticeship Project	Meeting	• Provided the Jackpine Mine and Pierre River Mine Public Disclosure • Provided the Jackpine Mine and Pierre River Mine schedules	None

17, 19	AENV	Public Notice	• Published Public Notice inviting comment on the Proposed Terms of Reference as follows:
			  • Calgary Herald, July 18, 2007
			  • Calgary Sun, July 18, 2007
			  • Edmonton Journal, July 18, 2007
			  • Edmonton Sun, July 18, 2007
			  • Fort McMurray Today, July 18, 2007
			  • Native Journal, July 17, 2007
			  • Slave River Journal, July 19, 2007
				None

20	Métis Nation of Alberta	Meeting	• Provided the Jackpine Mine and Pierre River Mine Public Disclosure • Provided the Jackpine Mine and Pierre River Mine schedules	None

Table 15-2: Public Consultation Activities – June 28 to November 2007 (cont'd)

Date	Stakeholder	Method of Contact	Summary of Issues Discussed	Outstanding Issues and Items for Follow-Up
July (cont'd)				
25	Fort McKay Group Companies	Meeting	• Provided the Jackpine Mine and Pierre River Mine Public Disclosure • Provided the Jackpine Mine and Pierre River Mine schedules • Discussed possible business contracting opportunities	None
30	TPA 2172	Telephone	• Received a call from the stakeholder to express concern about easy access to the trapper cabin and inappropriate use of the roadway by third-party revellers	• Contacted Albian Sands security, who contacted the third-party employer • Initiated a plan to block the roadway with concrete blocks and chain and, thereby, reduce the access to the trapper's cabin. The stakeholder was pleased.
30	Fort McMurray FN #468 IRC	Telephone	• Discussed possible meeting dates • Discussed the number of Elders in the community • Provided an update on the Jackpine Mine and Pierre River Mine schedules	Send possible dates for a next meeting to IRC.
31	TPA 1650	Telephone	• Received a call from the stakeholder to express concern about the state of the roadway to his trapper cabin	Scheduled a meeting for August 13, 2007, to discuss and review the issue.
August				
02	FM FN	Meeting	• Celebrated the local contract for the airstrip • Discussed, and provided the stakeholder with, the Jackpine Mine and the Pierre River Mine Public Disclosure • Provided the Jackpine Mine and Pierre River Mine schedules	None

Table 15-2: Public Consultation Activities – June 28 to November 2007 (cont'd)

Date	Stakeholder	Method of Contact	Summary of Issues Discussed	Outstanding Issues and Items for Follow-Up
August (cont'd)				

08	UTS and Teck Cominco (joint venture partners)	Meeting	• Provided an overview of the Pierre River Mine Project, with an emphasis on portions that interact with UTS Teck interests in Lease 14. Shell is seeking alignment on issues of mutual interest, including:
			  • determining a common mine boundary approach to minimize ore sterilization
			  • routing utility and access corridors across Lease 14
			  • building a site access road and Athabasca River bridge
			  • determining the impact of stream diversions on Lease 14
			• Agreed to conduct necessary further discussions
				• Determine mine boundary approach
				• Determine utility and access corridors
				• Determine the site access road and Athabasca River bridge
				• Determine stream diversions

08	Husky	Meeting	• Provided the Jackpine Mine and Pierre River Mine Public Disclosure • Provided the Jackpine Mine and Pierre River Mine schedules	None

14	MCFN	Rally	• Attended a rally on the Effects of Unfettered Oil Sands Development on Fort Chipewyan. Key messages were:
			  • put a moratorium on oil sands development
			  • get the government to recognize a duty to consult
			  • unite efforts between the First Nations and Métis
				N/A

14 - 16	MCFN	Youth and Elders retreat	• Participated in a youth and Elders retreat camp • Provided copies of the Public Disclosure	N/A

Table 15-2: Public Consultation Activities – June 28 to November 2007 (cont'd)

Date	Stakeholder	Method of Contact	Summary of Issues Discussed	Outstanding Issues and Items for Follow-Up
August (cont'd)				

16	ACFN	Meeting and presentation	• Presented an update on the proposed Jackpine Mine Expansion and Pierre River Mine projects
			• Did not address other agenda items, i.e., the request for permission to use TLU information, and the presentation on the proposed winter drilling program were not given because the agenda was pre-empted by a stakeholder Councillor with the following concerns:
			  • review of EIA to involve Elders
			  • cannot expect ACFN to approve movement and diversion of creeks. Will intervene on this matter.
			  • expect letter from Elders, Chief and Council regarding guarantee of $200 million of contracts
			  • request Shell to support ACFN to address issue of government's duty to consult being off-loaded to industry
			  • infringement of treaty rights related to not being able to access and use traditional lands
			  • request site visits with Elders and youth before areas are disturbed
			  • question regarding mining the Athabasca River – no
			  • question regarding the Jackpine Mine Expansion's need for a new water intake – no
				• Provide $200 million guarantee in work contracts
				• Follow up with Jim Tanner regarding the TLU information
				• Provide support for ACFN's issue of government's duty to consult regarding treaty rights
				• Discuss diversion of the Muskeg Creek
				• Schedule a site visit (see October 11, 2007)

29	MCFN	Telephone	• Discussed the Public Disclosure outline for the open house	Faxed outline of Public Disclosure to stakeholder.

Table 15-2: Public Consultation Activities – June 28 to November 2007 (cont'd)

Date	Stakeholder	Method of Contact	Summary of Issues Discussed	Outstanding Issues and Items for Follow-Up
August (cont'd)				
30	ACFN IRC	Meeting	• Met in Edmonton to review the progress on commitments delivery • Provided an update on the Jackpine Mine and Pierre River Mine	None
September				
05	Teck Cominco Metals	E-Mail	• Responded to a request regarding the potential supply and sale of oil sands froth from the Muskeg River Mine. Stated that Shell is unable to accommodate the request.	None
06	FM FN	Event	• Provided an update of the Jackpine Mine and the Pierre River Mine	None

11	Fort McKay FN and Fort McKay community	Open house	• Held an open house at Fort McKay Multiplex to outline expansion plans from:
			  • noon to 3:00 pm for 47 Elders
			  • 4:00 to 8:00 pm for eight community members
				None

12	General public in RMWB	Open house	• Held an open house at the Oil Sands Discovery Centre to outline expansion plans. About 86 community members attended the event that took place from 4:00 to 8:00 pm.	None
13	Métis Local #63	Meeting	• Discussed the Jackpine Mine and the Pierre River Mine Public Disclosure • Provided the Jackpine Mine and Pierre River Mine schedules • Discussed possible issues and concerns • Went over the regulatory process	None
17	Métis Local #1935	Telephone	• Discussed the letter sent from Local #1935 • Discussed issues and concerns	Asked to contact Local #1935 when a newer schedule was available.

Table 15-2: Public Consultation Activities – June 28 to November 2007 (cont'd)

Date	Stakeholder	Method of Contact	Summary of Issues Discussed	Outstanding Issues and Items for Follow-Up
September (cont'd)				
17 (cont'd)			• Provided the TOR schedule and gave an update on the Jackpine Mine and the Pierre River Mine projects • Answered all questions.	
18	RIWG Environment Committee	Meeting	• Updated the committee regarding the schedule for filing the Jackpine Mine and the Pierre River Mine applications and EIA	None
18	Athabasca Delta School	Telephone	• Provided details about the Jackpine Mine and Pierre River Mine open house • Faxed poster outlining the event to the school	None
18	MCFN	Telephone	• Provided details of the open house	None
19	• ACFN • MCFN • Métis Local 125 • Fort Chipewyan community	Open house	• Held an open house at the Mamawi Community Centre to outline expansion plans from noon to 3:00 pm and from 4:00 to 8:00 pm for about 100 community members	None
24	Métis Local #63	Telephone	• Discussed meeting dates for updates on the Jackpine Mine, the Pierre River Mine and the regulatory process	Send possible dates to Local #63
October				
01	Métis Local #63	Telephone	• Discussed signing a Good Neighbour Agreement • Provided an update on the projects	Chose October 30, 2007, to sign the agreement in the community
03	ACFN IRC	Telephone	• Discussed the winter drilling program open house	Set a date for the winter drilling program open house in the community
09	CPDFN IRC	E-mail	• Sent a follow-up e-mail enquiring if IRC had any questions related to the information package and CD sent to the IRC office explaining Shell's winter drilling program for 2007–2008	None

Table 15-2: Public Consultation Activities – June 28 to November 2007 (cont'd)

Date	Stakeholder	Method of Contact	Summary of Issues Discussed	Outstanding Issues and Items for Follow-Up
October (cont'd)				
11	ACFN AC	Meeting	• Presented the 101 Monitoring Presentation • Did a follow-up on seed collection • Capacity Building (student selection regarding Environmental Monitoring program)	None
11	Fort McMurray #468 FN IRC	E-mail	• Sent a follow-up e-mail enquiring if IRC had any questions related to the information package and CD sent to the IRC office explaining Shell's winter drilling program for 2007–2008	None
12	Fort McKay Elders Advisory Committee	Meeting	• Meeting was cancelled at the last minute. To be re-scheduled.	None

18	ACFN IRC	Meeting	• Met to:
			  • discuss terms of Application Review Protocol for the Jackpine Mine Expansion and the Pierre River Mine Project
			  • review and update progress on specific socio-economic commitments delivery
				None

23	MCFN IRC	Meeting	• Met to:
			  • discuss terms of Application Review Protocol for the Jackpine Mine Expansion and the Pierre River Mine Project
			  • review and update progress on socio-economic commitments delivery
			  • deliver presentation on Shell's winter drilling program for 2007–2008
				None

Table 15-2: Public Consultation Activities – June 28 to November 2007 (cont'd)

Date	Stakeholder	Method of Contact	Summary of Issues Discussed	Outstanding Issues and Items for Follow-Up
October (cont'd)				

29	Fort McKay	Meeting	• Met to:
			  • discuss terms of Application Review Protocol for the Jackpine Mine Expansion and the Pierre River Mine Project
			  • provide an update on the Muskeg River Mine and the Jackpine Mine flare stack, and impact on Fort McKay
			  • provide update on the airstrip
				None

30	Métis Nation, Local 63	Annual general meeting	• Good Neighbour Stewardship Agreement	None
31	Fort McMurray FN #468 IRC	Telephone	• Discussed buying another TLU booklet from FN IRC	Send payment and booklet
November				
01	ACFN	ACFN community open house to present Industry Upcoming Winter Land Plans	• Attended the open house, where all industry developers and provincial representatives were invited to attend to present plans and answer questions regarding exploration and drilling and other land activities proposed for 2007–2008	None
13	FM FN IRC	Telephone	• Discussed flare stacks located at the Jackpine Mine and the Pierre River Mine • Provided contact names	None
16	• ACFN • MCFN FMFN Métis Local 63 • Métis Local 1935 • Municipality • Province	Albian Village open house	• Provided a Jackpine Mine and Pierre River Mine update, including schedules • Discussed possible future business contracting opportunities	None

APPROACH

Shell supports, and is committed to, working with regulatory agencies and regional stakeholders to facilitate responsible development, following sustainable development principles, hence balancing resource conservation, environmental protection and the enhancement of regional socio-economic opportunities.

Oil sands industry members regularly assess opportunities to work together cooperatively in the region. Within certain practical limits, such as the physical location and timing of development, opportunities for regional cooperation include:

- managing lease boundary resource recovery issues, and closure and drainage plans
- completing regional environmental management and monitoring
- conducting technological and environmental research
- conducting regional environmental baseline studies and sharing site-specific information
- conducting infrastructure impact studies
- consulting with stakeholders

COOPERATION INITIATIVES

Shell's regional cooperation has led to a number of specific actions and initiatives, including:

- entering into cooperation agreements with adjoining oil sands developers, which promotes continued cooperation on:
  - developing estimates of mine boundary resources to facilitate discussions on lease boundary management and conservation
  - planning utility and access corridors

COOPERATION INITIATIVES (cont'd)

- coordinating operations, reclamation and closure opportunities, including stream diversions and closure drainage
- protecting the quality of the Athabasca River
- sharing environmental data and other information

- collaborating on the collection of baseline environmental information, and on research and monitoring studies with other regional developers
- locating regional access roads and corridors. Through the Regional Issues Working Group (RIWG) transportation committee, industry and government are evaluating options for permanent access and utility corridors to support oil sands development.
- coordinating emergency response services between operators and the Regional Municipality of Wood Buffalo

OTHER REGIONAL INITIATIVES

Athabasca Oil Sands Facilitation Committee

To help develop strategies to resolve the issues identified by planning agencies, the Athabasca Oil Sands Facilitation Committee was formed in 1997. Current membership includes:

- senior representatives of oil sands resource developers
- the Mayor of the Regional Municipality of Wood Buffalo
- the Chair of the Resource Development Committee, Regional Municipality of Wood Buffalo

Regional Issues Working Group

Since its inception in 1997, Shell has provided support and staff participation for the Regional Issues Working Group (RIWG). The RIWG was created by industry and municipality members to work with other agencies in identifying and understanding various project scenarios and potential socio-economic and environmental impacts. The RIWG became a registered non-profit society with an elected board of directors in 2004, and is funded through industry members.

The RIWG provides multiple users with updated information through its urban population impact database model, which details regional development activities to assist with infrastructure planning and service delivery. It also provides information on regional issues through its executive director, website and various issues-based subcommittees.

Canadian Oil Sands Network for Research and Development

Shell contributes to the advancement of oil sands-related technology through extensive involvement in joint industry research in the areas of environment, extraction and tailings, through the Canadian Oil Sands Network for Research and Development (CONRAD) and other organizations.

Shell has been an active member of CONRAD for many years. CONRAD's role is to coordinate and integrate research done by the private sector, government and academics. CONRAD has formed research groups in the following areas:

- the environment
- extraction
- upgrading
- in situ recovery

Environmental Research Group

The Environmental Research Group is responsible for prioritizing, coordinating, funding and communicating the results of environmental research. Current research efforts focus on:

- terrestrial soil reconstruction and vegetation re-establishment
- water quality and aquatic resources, such as fish tainting
- the re-establishment of wetlands

Extraction Research Group

The Extraction Research Group has been chaired for the past several years by an Albian Sands representative and currently consists of four focus groups:

- Extraction Fundamentals
- Water Chemistry
- Tailings Management
- Froth Treatment

Each of these focus groups meets regularly to identify collaborative projects aimed at developing a more fundamental understanding of the science of oil sands extraction processes. Recent examples include a comprehensive literature review by CANMET of extraction fundamentals research and a $3 million thickened paste pilot project at Syncrude's Aurora site.

Network Coordinating Council

Shell is also a member of the Network Coordinating Council, a high-level planning committee.

Table 16-1 summarizes Shell's regional cooperation involvement with industry and other stakeholders.

Table 16-1: Regional Cooperation Involvement

Group	Committee or Task Group	Representative From	Role
Alberta Apprenticeship Program		Shell	Representative
Alberta Chamber of Resources	Environment Committee	Albian Sands	Board member
		Albian Sands	Representative
Alberta Municipal Supervisors Association		Albian Sands	Representative
Athabasca Tribal Council	Communications	Albian Sands	Representative
	Executive	Shell (2)	Representatives
	Indigenous Games	Albian Sands	Representative
	Management	Shell	Co-chair
	Regional Prescription Drug Abuse Strategy Committee	Albian Sands	Representative
	Sustainable Employment	Albian Sands	Representative
Canadian Oil Sands Network for Research and Development	Environmental Research Group	Albian Sands	Representative
	Extraction Research Group	Albian Sands	Representative
Community Careers Cooperative		Albian Sands	Board member
	Career Preparation Advisory Council	Albian Sands	Representative
	Registered Apprentice Program	Albian Sands	Representative
	Trades Advisory Council	Albian Sands	Representative
Cumulative Environmental Management Association	Management Committee	Shell	Vice-president
	Member's Board	Shell	Representative
	NO_x and SO_x Management Working Group	Shell	Representative
	Reclamation Working Group	Albian Sands	Representative
	Surface Water Working Group	Shell	Representative
	Sustainable Ecosystems Working Group	Shell	Representative
	Trace Metals and Air Contaminants Working Group	Shell	Representative
	Traditional Environmental Knowledge Committee	Albian Sands	Representative
Dangerous Goods Response Team		Albian Sands	Representative
End Land Use and Closure Committee	Fort McKay First Nation, Athabasca Chipewyan First Nation, Mikisew Cree First Nation	Albian Sands	Chair
Forest Resource Planning	Genetic Seed, Growth and Yield	Albian Sands	Representative
Fort McKay Air Quality Notification		Shell	Representative
Fort McMurray Chamber of Commerce		Albian Sands	Members (2)
Groundwater Research Group		Albian Sands	Representative
HR Managers Oilsands Committee		Albian Sands	Representative

Table 16-1: Regional Cooperation Involvement (cont'd)

Group	Committee or Task Group	Representative From	Role
Métis – Industry Consultation Agreement		Albian Sands	Representative
Mining Association of Canada		Albian Sands	Board member
Mining Industry Advisory Council, U of A		Albian Sands	Board member
Northeast Alberta Aboriginal Business Association		Albian Sands	Member
Oil Sands Bird and Wildlife Protection Committee		Albian Sands	Representatives
Oil Sands Discovery Centre		Albian Sands	Board member
Oil Sands Safety Association		Albian Sands	Chair
Partners in Emergency Protection	Communications	Albian Sands	Representative
Regional Aboriginal Recognition Awards		Albian Sands	Representative
Regional Aquatics Monitoring Program	Acid Sensitive Lakes	Albian Sands	Representative
	Benthic Invertebrates	Albian Sands	Representative
	Fisheries	Albian Sands	Representative
	Hydrology	Albian Sands	Representative
	Steering	Albian Sands	Chair
	Water Quality and Sediment	Albian Sands	Representative
	Wetlands Vegetation	Albian Sands	Representative
	Funding	Albian Sands	Representative
Regional Issues Working Group	Aboriginal Affairs Consultation	Albian Sands (2)	Representatives
	Addictions and Mental Health	Albian Sands	Representative
	Administration	Shell	Representative
	Cogeneration	Albian Sands	Representative
	Communications	Shell	Representative
	East Side Corridor	Shell	Representative
	Education	Albian Sands	Chair
	General Membership	Shell	Representative
	General Operations	Albian Sands	Representative
	Housing	Albian Sands (2)	Representatives
	Regional Economic	Albian Sands	Representative
	Transportation	Shell	Representative
	Environment	Shell and Albian Sands	Representative
Towards Sustainable Mining		Shell	Representatives
Weed Prevention and Management		Albian Sands	Representative
Wood Buffalo Environmental Association	Ambient Air	Albian Sands	Representative
	Communications	Albian Sands	Representative
	Funding	Albian Sands	Representative
	Governance	Albian Sands	Representative

Table 16-1: Regional Cooperation Involvement (cont'd)

Group	Committee or Task Group	Representative From	Role
Wood Buffalo Environmental Association (cont'd)	Human Exposure	Shell	Representative
	Terrestrial Environmental Effects Monitoring	Albian Sands	Chair
Wood Buffalo Major Projects Coordination		Shell	Member
Wood Buffalo Partners in Aboriginal Skills and Employment Partnership		Shell	Representative
Wood Buffalo Taxation Committee		Albian Sands	Representative

REGIONAL SUSTAINABLE DEVELOPMENT INITIATIVES

In support of the Regional Sustainable Development Strategy and other regulatory requirements, industry, government and other key stakeholders have established several multi-stakeholder environmental management, monitoring and research committees (see Figure 16-1). Shell and Albian Sands actively participate in these committees.

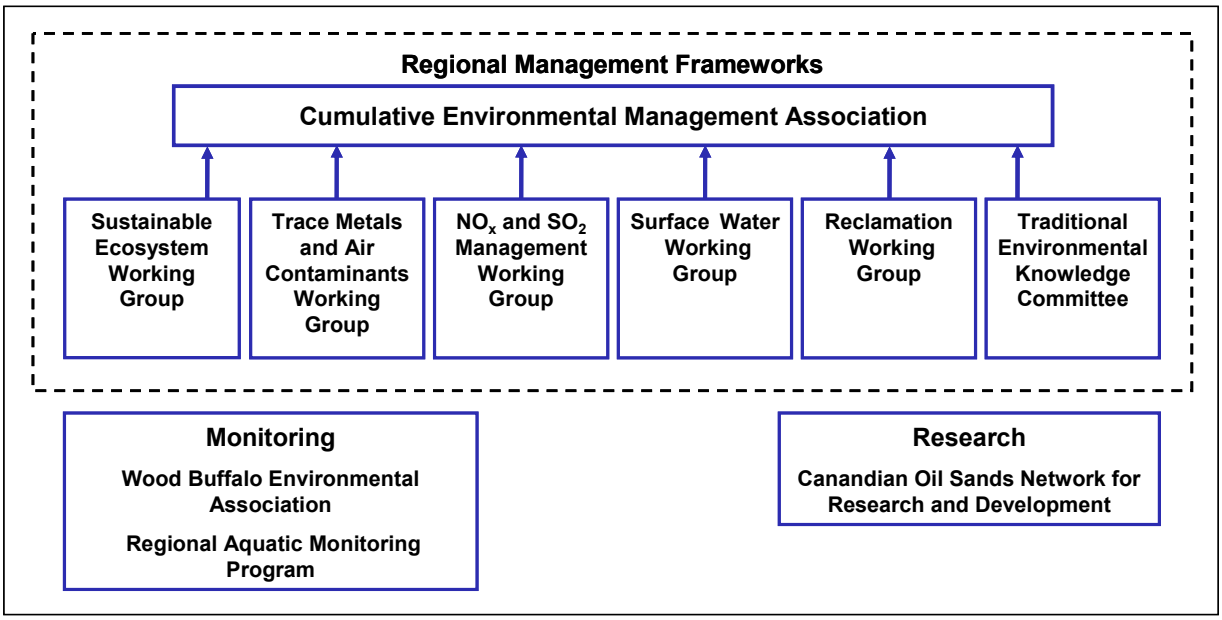


Figure 16-1: Regional Environmental Committees

Table 16-2 lists the regional environmental management initiatives in which Shell or Albian Sands participates. Regional environmental monitoring activities are listed in Table 16-3.

Table 16-2: Regional Environmental Management Committees and Working Groups

Working Group	Purpose
Cumulative Effects Management Association (CEMA)	Develop regional management systems, as a multi-stakeholder committee, to address cumulative environmental effects. Working groups include SEWG, TMAC WG, NSMWG, SWWG and RWG.
Sustainable Ecosystem Working Group (SEWG)	Modify existing systems for managing cumulative effects on ecosystems and landscapes in the region, including wildlife, fish, soils, vegetation biodiversity, and cultural and historical resources.
Trace Metal and Air Contaminants Working Group (TMAC WG)	Assess risks posed to human health and ecosystems by airborne trace metals and air contaminants. Recommend changes to existing management systems to address these risks.
NO_x and SO_x Management Working Group (NSMWG)	Recommend management plans for current and projected NO_x and SO_x emission levels to address concerns on acidification, ozone and eutrophication.
Surface Water Working Group (SWWG)	Establish criteria and systems to address: • in-stream flow needs of the lower Athabasca River • water quality of the Athabasca River • integrity of the Muskeg River watershed
Reclamation Working Group (RWG)	Make recommendations on reclamation, based on community and stakeholder values, traditional knowledge, scientific information, fiscal reality and provincial policy. Currently, programs address management, monitoring and research issues related to soil, vegetation, wildlife, biodiversity and wetlands.
Traditional Environmental Knowledge Committee (TEK)	Provide direction on the collection and integration of traditional environmental knowledge in the management systems being developed by CEMA working groups.

Table 16-3: Regional Environmental Monitoring Committees

Working Group	Purpose
Regional Aquatic Monitoring Program (RAMP)	RAMP is a multi-stakeholder committee that designs and implements regional monitoring programs to collect information on hydrology, water quality, sediment, fisheries, benthic invertebrates, wetland vegetation and acid sensitive lakes. Information is used to verify cumulative effects of development and monitor for trends of change in regional aquatic resources.
Wood Buffalo Environmental Association (WBEA)	WBEA is a multi-stakeholder committee that designs and implements regional monitoring programs on environmental quality (primarily air quality) in the Wood Buffalo Region. The subcommittees include: • Terrestrial Environmental Effects Monitoring – monitors effects of air emissions on terrestrial and aquatic ecosystems and traditional resources • Ambient Air – monitors ambient air quality through continuous trailers and passive monitors • Health Exposure – monitors human health related to exposure to air emissions

MINE PLANNING COORDINATION

A key feature of any oil sands development is a mine plan that is based on a balanced consideration of resource recovery, environmental protection, economics and extraction process efficiency. As adjacent leaseholders with concurrent developments, Shell, Canadian Natural Resources Limited (CNRL) and Teck/UTS have expressed a desire to work together and, in concert with regulatory agencies, to:

- develop sensible, effective, integrated mine plans to recover economic lease boundary resources
- have coordinated and integrated reclamation and drainage plans during operations and at closures

The motivation for these discussions is to ensure that plans do not preclude or marginalize future resource recovery potential, and to ensure that operational and closure reclamation and drainage plans are coordinated and integrated within the Muskeg River watershed to reduce and mitigate environmental effects.

LEASE BOUNDARY AGREEMENTS

The Pierre River Mine shares a common mine boundary with CNRL Leases 11, 12 and 13 and Teck/UTS Lease 14. Shell has approached all parties and is committed to defining effective boundary management plans, in the same way that it has worked with adjoining landholders on its leases east of the Athabasca River, such as Leases 13, 88 and 89, the Muskeg River Mine, Jackpine Mine – Phase 1 and the Jackpine Mine Expansion.

A primary concern about independent oil sands mining projects operating with a common boundary is to ensure that the potential sterilization of economic ore is minimized.

Shell expects that mutually acceptable lease boundary agreements will be put in place with CNRL and Teck/UTS. Based on initial discussions, a conceptual boundary agreement to facilitate the orderly and effective mining of oil sands from the respective leases might include specific areas, such as:

- coordinating mine plans
- recognizing the timing of mining activities

LEASE BOUNDARY AGREEMENTS (cont'd)

- optimizing the construction of storage facilities
- developing reclamation and closure strategies
- managing ownership and disposition of resources and stripping material
- calculating a compensation basis

FIRST NATIONS AND MÉTIS AGREEMENTS

As part of working together to identify and, where possible, resolve First Nations and Métis issues related to resource development, Shell has been, and will continue to be, involved with committees and initiatives associated with the following agreements:

- the Athabasca Tribal Council – All Parties Core Agreement
- the Métis–Industry Consultation Agreement
- the Aboriginal Skills and Employment Program Contribution Agreement

Shell has also established Environmental and Socio-Economic Agreements with the:

- Fort McKay First Nation
- Mikisew Cree First Nation
- Athabasca Chipewyan First Nation

Athabasca Tribal Council – All Parties Core Agreement

Shell staff participate in the executive group and management committee and various business plan committees of the Athabasca Tribal Council. The intent of the Athabasca Tribal Council – All Parties Core Agreement is to provide a framework for industry and the five First Nations of the Wood Buffalo Region to work together with three levels of government to resolve regional First Nations issues related to resource development.

Métis-Industry Consultation Agreement

Albian Sands provides funding for the Métis-Industry Consultation Agreement and participates on its steering committee to support information and consultation activities associated with Métis issues and concerns regarding resource development in the Wood Buffalo region.

ACCESS MANAGEMENT

Access to the Pierre River Mine site will be from Highway 63 northwest on a new bridge across the Athabasca River. This access will be required initially to bring equipment in for plant construction and for the mine. Shell will manage site access, including use of the private bridge.

SCOPE

A single EIA has been prepared to assess the combined effects of the Jackpine Mine Expansion and the Pierre River Mine (referred to in the EIA as the Project). This section summarizes the potential Project-related impacts on the natural and human environment discussed in the EIA. These impacts were assessed, the residual impacts ranked, and environmental consequences determined, including the:

- effects that could result from the Project's development, operations and reclamation
- measures to avoid or mitigate impacts
- residual effects of the Project, including the direction, magnitude, frequency, duration, reversibility and geographic extent
- monitoring programs to:
  - verify the predicted residual effects
  - evaluate the effectiveness of mitigation plans and environmental protection measures
  - propose research and adaptive management programs for the Project

KEY ENVIRONMENTAL ISSUES

The key issues associated with the Project's development were identified through a series of key questions that framed the relationships between the Project and potential environmental impacts. This transparency allows reviewers to understand the rationale and assumptions used to make conclusions.

The first step in the evaluation process was to identify the issues that were of greatest concern to the stakeholders and regulators. This was initiated by evaluating:

- the issues and responses in recent oil sands EIAs
- recent oil sands regulatory application hearings

KEY ENVIRONMENTAL ISSUES (cont'd)

- the Regional Sustainable Development Strategy (RSDS) for the Athabasca Oil Sands Region
- the Cumulative Environmental Management Association (CEMA)
- other relevant documents
- information received during consultation with key Project stakeholders

The key oil sands environmental assessment issues identified through regional initiatives, such as RSDS, or through consultation, included:

- the integrity of the Muskeg River watershed
- sustainable ecosystems and end land use
- air emissions and their effects on human health, wildlife and vegetation
- water quality and quantity
- fish and fish habitat
- vegetation diversity
- wildlife and wildlife habitat

The key issues for the Project are related to:

- the location of the Project
- aquatic resources
- air quality
- noise
- terrestrial resources

ASSESSMENT CASES

The EIA did not assess the effects of the Project in isolation, but examined the incremental effects of the Project on the effects associated with three cases, as defined in compliance with the EIA Terms of Reference:

- the Base Case
- two assessment cases:
  - the Application Case
  - the Planned Development Case

Base Case

The Base Case includes the existing environmental conditions as well as existing and approved projects or activities within the study area. This cumulative effects assessment includes both the existing and approved activities because the potential effects of the project being assessed need to be measured against all currently approved developments and their associated impacts.

Information to define the Base Case conditions for the Project was gathered from various sources, such as the original EIA that Shell submitted for Jackpine Mine – Phase 1, other regional information, and specific environmental setting studies previously completed for the Project.

Application Case

The Application Case is the Base Case, plus the Project.

Planned Development Case

The Planned Development Case is the Application Case, plus other planned projects. The methodology for completing the Planned Development Case is the same as for the Application Case and includes:

- assessing and discussing the cumulative environmental effects that are likely to result from the Project in combination with other existing, approved and planned projects in the region that could reasonably be considered to have a combined effect. This includes industrial projects, as well as activities associated with land use and infrastructure.

- explaining the approach and methods used to identify and assess cumulative effects, including cooperative opportunities and initiatives undertaken to further the collective understanding of cumulative effects and providing a record of all assumptions, confidence in data and analysis to support conclusions

A planned project is considered any project or activity that has been publicly disclosed up to six months before the submission of a project's application and EIA. The information used for planned projects in the EIA is based on the information publicly available in July 2007. Projects disclosed after that date, or whose approvals were issued or plans modified after July 2007, were considered in the EIA, based on the relevant information available at that time.

The Planned Development Case assessment is completed only when the residual impacts predicted for the Application Case are rated greater than negligible. The Planned Development Case provides a conservative assessment of social and environmental conditions, because the Project included in the assessment might or might not proceed.

Cumulative Effects Assessments

The Application and Planned Development cases are also cumulative effects assessments. These cumulative effects assessments have been completed to comply with the requirements for cumulative effects assessments, according to:

- the *Cumulative Effects Assessment in Environmental Impact Assessment Reports under the EPEA*

- Section 16 of the *Canadian Environmental Assessment Act* (*CEAA*)

Cumulative Effects Assessments (cont'd)

The process for completing the cumulative effects assessment as a component of the EIA included considering guidelines provided in the *Athabasca Oil Sands Cumulative Effects Framework Report* and the *Cumulative Effects Practitioners Guide.*

LOCAL AND REGIONAL STUDY AREAS

The EIA considered environmental consequences associated with the development of the Project in a project development area within local study areas and regional study areas. The local study areas were used to focus on, and evaluate, environmental and cultural resources that might be directly affected by the Project. The regional study areas were used to evaluate the effects of the Project in a broader geographic and ecological context.

MITIGATION AND REGIONAL MANAGEMENT

Design features and mitigation plans have been incorporated into the Project design to prevent or reduce potential project-related environmental impacts. Proposed mitigation is summarized for each environmental component.

Regional management systems that address cumulative effects, and that Shell will support, were developed by multi-stakeholder committees. The systems are described in each environmental component section of the EIA.

MONITORING, RESEARCH AND ADAPTIVE MANAGEMENT

The proposed monitoring programs for each of the environmental components provide a means of verifying the:

- predicted environmental effects of the Project
- effectiveness of mitigation plans and environmental protection plans

Shell's environmental monitoring programs comply with the approvals issued under the EPEA and *Water Act* for the existing Jackpine Mine – Phase 1. These existing monitoring programs will be amended, where practical, to include the additional requirements associated with the Project.

The regional and project-specific monitoring and research programs that Shell will support as part of adaptive management are described for each environmental component.

Adaptive management is a continuous improvement process of planning, implementing and evaluating results through monitoring and research programs, and developing new plans from lessons learned. Shell included lessons learned from its existing operations in its planned mitigation and monitoring activities for

the Project. This process allows best practices to be developed through continuous learning and renewal of plans.

ENVIRONMENTAL COMPONENTS SUMMARIZED

The following environmental components are summarized in the remainder of this section:

- air quality (see Section 17.2)
- noise (see Section 17.3)
- environmental health (see Section 17.4)
- aquatic resources, including:
    - hydrogeology (groundwater) in Section 17.5
    - hydrology in Section 17.6
    - surface water quality in Section 17.7
    - aquatic health, fish and fish habitat in Section 17.8
- terrestrial resources (see Section 17.9)
- human environment (see Section 17.10)
- historical resources (see Section 17.11)

For a summary of the Socio-Economic Impact Assessment (SEIA), see Section 18.

APPLICATION FOR APPROVAL OF THE PIERRE RIVER MINE PROJECT
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AIR QUALITY

SCOPE OF ASSESSMENT

The air quality assessment of the Project included evaluating three distinct assessment scenarios:

- the Base Case, which includes an assessment of the cumulative air quality effects from the existing and approved industrial emission sources assuming full operation within the region, as well as estimated emissions from transportation and residential activities. Although the sources considered in the Base Case have been approved, it will be several years before the activities in the region increase from the existing levels of emissions to those used in the Base Case. The Base Case represents the cumulative load on the airshed that can occur without the need for any additional regulatory approvals.
- the Application Case, which provides a cumulative assessment of the emissions from the Project in combination with Base Case emissions in the region. The Application Case represents the load on the airshed once the Project begins operating.
- the Planned Development Case, which includes a cumulative assessment of the existing and approved projects in the region, the Project and other publicly disclosed projects in the region. The Planned Development Case includes planned projects for which their proponents have not yet received approval, and some projects for which their proponents have not yet applied for approval. Therefore, the emissions used in the Planned Development Case are speculative and based on the information available when the EIA was prepared. Therefore, the emissions that actually occur in the future might be lower than those estimated in the Planned Development Case.

DISPERSION MODELLING

For each of the scenarios, a list of the regional emissions considered in the assessment was compiled. The CALPUFF dispersion model was then run in the dynamic (3-D) mode to determine ground-level concentrations and deposition levels of:

- sulphur dioxide (SO_2)
- nitrogen dioxide (NO_2)

DISPERSION MODELLING (cont'd)

- acid deposition expressed as potential acid input (PAI)
- carbon monoxide (CO)
- hydrogen sulphide (H_2S) and selected total reduced sulphur (TRS) compounds
- benzene and selected volatile organic compounds (VOCs)
- fine particulate matter ($PM_{2.5}$)
- selected polycyclic aromatic hydrocarbon (PAH) compounds
- selected trace metals

Concentrations of SO_2 and NO_2 and acid deposition (as PAI) were determined over the entire modelling domain, and the results presented for both the regional and local study areas. Concentrations of the parameters, excluding PAI, were determined for the selected regional community receptors, which include:

- nine communities in Alberta
- two communities in Saskatchewan
- two regional worker camps
- 12 receptors representing locations near the Project, where people participating in traditional land uses could experience prolonged exposure to air emissions

The 3-D version of the CALPUFF model was selected for assessing the Project's air emissions, to be consistent with the modelling completed for recent EIAs in the region. AENV also identified this model as being appropriate for modelling in the region.

For all compounds assessed, the peak concentrations include the highest 1-hour predictions from the CALPUFF model. The maximum values exclude the eight highest 1-hour predictions, as recommended by AENV for determining compliance with the Alberta Ambient Air Quality Objectives (AAAQOs).

The effects associated with the predicted concentrations and deposition values were assessed by comparing the modelling results to established AAAQOs or other applicable objectives and standards. However, not all of the parameters have air quality objectives and standards against which the predicted concentrations could be evaluated. In such cases, the results of the modelling analyses were evaluated in other EIA components. For a summary of these evaluations, see the Health Assessment and the Air Emissions Effects on Ecological Receptors in EIA Volume 3, Section 5.

SUMMARY OF RESULTS

The Project is in an airshed that has numerous other sources of emissions. Despite the mitigation measures for the Project, the air emissions might result in changes in the ambient air quality.

Of the 129 ambient air quality parameters assessed in the Application Case, all are classified as having either a negligible or low environmental consequence.

The Clean Air Strategic Alliance (CASA) and the Cumulative Environmental Management Association (CEMA) frameworks for managing acid deposition in Alberta consider management units represented by grid cells that are 1° by 1° in size. The CEMA framework also considers smaller management units that are assessed in the Air Emissions Effects on Ecological Receptors section (see EIA Volume 3, Section 5.5). Because the predicted PAI in the Base Case already exceeds the guidelines, the Project's oxides of nitrogen (NO_x) and SO_2 emissions result in an increase in the areas that have PAI values above 0.17, 0.25, 0.50 and 1.0 keq/ha/a, in both the regional and local study areas.

Although emissions from the Project are predicted to increase PAI levels in 18 of the 20 grid cells superimposed on the modelling domain, the emissions are not predicted to result in any additional grid cells having PAI levels that exceed the monitoring, target or critical loads adopted by CASA. In addition, the results of assessing the cumulative SO_2 and NO_x emissions for the Application Case, do not show the 0.17 keq/ha/a PAI isopleth extending into Saskatchewan.

The effects of the Project's emissions were also assessed at community receptors. Although the emissions have a small incremental effect on the predicted concentrations of several air components at these receptors, no predicted levels occur above the AAAQOs or other applicable criteria. The model predictions at Descharme Lake and La Loche, Saskatchewan, show negligible increases as a result of the Project (less than 0.5 µg/m³ for SO_2 and NO_2).

Regional Emissions

Table 17-1 summarizes the emissions of key air quality parameters for the Base, Application and Planned Development cases.

Table 17-1: Summary of Base, Application and Planned Development Case Air Emissions

Air Quality Parameter	Base Case	Project	Application Case	Planned Development Case	Change * Resulting from Project (%)
SO_2 (t/cd)	274.07	7.88	281.94	322.67	2.9
NO_x (t/d)	483.35	12.19	495.55	633.90	2.5
CO (t/d)	419.83	19.46	439.29	511.43	4.6
$PM_{2.5}$ (t/d)	31.24	0.44	31.69	39.44	1.4
VOC (t/d)	681.83	25.40	707.23	880.38	3.7
TRS (t/d)	7.68	0.22	7.90	9.33	2.8
Note *: Represents change between Base Case and Application Case.					

Regional Emissions (cont'd)

The increase in SO_2 emissions as a result of the Project, compared with Base Case emissions, is estimated to be 2.9%. The increase in NO_x is estimated to be 2.5%. The ambient predictions for the Base, Application and Planned Development cases are summarized in EIA Volume 3, Appendix 3-9.

Base Case Air Quality

The Base Case emissions include a total of 274.1 t/cd of SO_2 emissions and 483.4 t/d of NO_x emissions. Although the Base Case sources have been approved, it will take several years before the activities in the region increase emissions from the current level to the levels assessed.

Table 17-2 shows the maximum Base Case predictions of 1-hour, 24-hour and annual average ground-level SO_2 and NO_2 concentrations in the local and regional study areas (outside of developed areas). The 24-hour and annual NO_2 predictions are above the AAAQOs in the regional study area, and result from the existing and approved developments. The model performance evaluation (see EIA Volume 3, Appendix 3-8) indicates that NO_x and NO_2 predictions near open pit mine sites are over-predicted. This conservatism is believed to be associated with the estimated mine fleet vehicle emissions. The NO_x –SO_2 Management Working Group (NSMWG) is currently investigating approaches to provide more realistic NO_x and NO_2 predictions.

The Base Case PAI predictions were made using the 3-D version of the CALPUFF dispersion model in combination with background PAI values determined by AENV. The predictions indicate that areas with PAI levels above 0.17, 0.25, 0.50 and 1.0 keq/ha/a are possible within the regional and local study areas.

To help manage acid deposition in Alberta, CASA has adopted a series of critical, target and monitoring loads on the basis of 1° by 1° grid cells. Twenty such grid cells, all classified as being sensitive to acid deposition, are superimposed on the air modelling domain. Base Case PAI levels are above 0.25 keq/ha/a in the two grid cells containing most of the approved oil sands operations. None of the remaining 18 grid cells have PAI levels above the 0.17 keq/ha/a monitoring load.

In addition to the CASA framework, a region-specific management system has been developed through the NSMWG of CEMA and adopted in the oil sands region. This framework, which combines predicted acid deposition rates with the sensitivity of the receiving environment, is discussed in the Air Emissions Effects on Ecological Receptors (see EIA Volume 3, Section 5.5).

At the regional community receptors, all Base Case predictions of compounds with AAAQOs are below the AAAQO levels for these compounds. The 98th percentile 24-hour Base Case $PM_{2.5}$ concentrations at regional community receptors are all below the Canada-wide standard of 30 $\mu g/m^3$.

In addition to compounds for which AAAQOs are available, Base Case predictions were made for selected TRS, VOC and PAH compounds and for selected trace metals. The evaluation of possible effects of these compounds is presented in EIA Volume 3:

- Section 5.3 for human health
- Section 5.4 for wildlife health

Table 17-2: Summary of Local and Regional Base Case Air Quality Predictions

Parameter	Maximum Concentration[1, 2] (µg/m³)	Number of Occurrences Above AAAQO[2, 3]	Area Above AAAQO[2, 3] (ha)
Local Study Area:			
• 1-hour SO_2	74.9	0	0
• 24-hour SO_2	46.9	0	0
• Annual average SO_2	6.9	0	0
• 1-hour NO_2	189.8	0	0
• 24-hour NO_2	182.1	0	0
• Annual average NO_2	51.6	0	0
Regional Study Area:			
• 1-hour SO_2	276.2	0	0
• 24-hour SO_2	144.2	0	0
• Annual average SO_2	11.3	0	0
• 1-hour NO_2	285.3	0	0
• 24-hour NO_2	**261.6**	2	1,694
• Annual average NO_2	**65.3**	1	<1

Note: Values in bold are above the applicable air quality objective or criterion.

1. Maximum predictions exclude the eight highest 1-hour concentrations, as per the Alberta model guidelines.
2. All results exclude developed areas. Developed areas include the project development area and existing and approved open pit mines and upgrading complexes within the regional and local study areas.
3. The AAAQOs for SO_2 are 450 µg/m³ (1-hour), 150 µg/m³ (24-hour) and 30 µg/m³ (annual). The AAAQOs for NO_2 are 400 µg/m³ (1-hour), 200 µg/m³ (24-hour) and 60 µg/m³ (annual).

Application Case Air Quality

Of the 129 ambient air quality parameters assessed in the Application Case, all are rated as having either a negligible or low environmental consequence.

The emissions associated with the Project (shown previously in Table 17-1) result in an increase of:

- 7.9 t/d of SO_2
- 12.2 t/d of NO_x
- 19.5 t/d of CO

Application Case Air Quality (cont'd)

- 25.4 t/d of VOCs
- 19.5 t/d of CO
- less than 0.5 t/d of $PM_{2.5}$ and TRS

Table 17-3 shows the maximum Application Case predictions of 1-hour, 24-hour and annual average ground-level SO_2 and NO_2 concentrations in the local and regional study areas, excluding developed areas. Within the regional and local study areas, the Project's SO_2 emissions have a negligible incremental effect on the 1-hour, 24-hour and annual SO_2 predictions, excluding the developed areas. No exceedances of SO_2 AAAQOs occur in the communities. The Project's NO_x emissions also have a negligible incremental effect on the 1-hour, 24-hour and annual NO_2 predictions, excluding developed areas. The maximum 1-hour, 24-hour and annual NO_2 levels predicted in the local study area are below the AAAQO levels. In the regional study area, the Application Case operations are predicted to result in:

- 1-hour NO_2 concentrations that are below the 1-hour AAAQO of 400 µg/m³
- 24-hour NO_2 concentrations that exceed the 24-hour AAAQO of 200 µg/m³
- annual NO_2 concentrations that exceed the annual AAAQO of 60 µg/m³

These exceedances are a result of approved projects in the region.

Because the PAI from the Base Case already exceeds the CASA guidelines for PAI, the NO_x and SO_2 emissions from the Project result in an increase in the areas that have PAI levels above 0.17, 0.25, 0.50 and 1.0 keq/ha/a, within the regional and local study areas. Although emissions from the Project are predicted to increase PAI levels in 18 of the 20 grid cells superimposed on the modelling domain, the emissions are not predicted to result in any additional grid cells having PAI levels that exceed the monitoring, target or critical loads adopted by CASA. Also, the assessment of the cumulative SO_2 and NO_x emissions from existing and approved developments in combination with the Project's emissions do not result in the 0.17 keq/ha/a PAI isopleth extending into Saskatchewan. The effect of emissions from the Project on the acid deposition management framework adopted by CEMA is addressed in Air Emissions Effects on Ecological Receptors (see EIA Volume 3, Section 5.5).

The effects of the Project's emissions were also assessed at community receptors. Although the emissions have a small incremental effect on the predicted concentrations of several air components at the receptors, no concentrations occur above the AAAQO levels or other applicable criteria. The model predictions at Descharme Lake and La Loche, Saskatchewan, show negligible increases as a result of the Project (less than 0.5 µg/m³ for SO_2 and NO_2).

Table 17-3: Summary of Local and Regional Application Case Air Quality Predictions

Parameter	Maximum Concentration[1][2] (µg/m³)	Number of Occurrences Above AAAQO[2][3]	Area Above AAAQO[2][3] (ha)
Local Study Area:			
• 1-hour SO_2	74.1	0	0
• 24-hour SO_2	46.7	0	0
• Annual average SO_2	5.5	0	0
• 1-hour NO_2	189.9	0	0
• 24-hour NO_2	182.1	0	0
• Annual average NO_2	46.3	0	0
Regional Study Area:			
• 1-hour SO_2	275.8	0	0
• 24-hour SO_2	143.9	0	0
• Annual average SO_2	11.4	0	0
• 1-hour NO_2	285.4	0	0
• 24-hour NO_2	261.7	2	1,702
• Annual average NO_2	65.5	1	<1

Note: Values in bold are above the applicable air quality objective or criterion.

1. Maximum predictions exclude the eight highest 1-hour concentrations, as per the Alberta model guidelines.
2. All results exclude developed areas. Developed areas include the project development area and existing and approved open pit mines and upgrading complexes within the regional and local study areas.
3. The AAAQOs for SO_2 are 450 µg/m³ (1-hour), 150 µg/m³ (24-hour) and 30 µg/m³ (annual). The AAAQOs for NO_2 are 400 µg/m³ (1-hour), 200 µg/m³ (24-hour) and 60 µg/m³ (annual).

MITIGATION, MONITORING AND MANAGEMENT

The Project has been designed to limit effects on air quality in the oil sands region rather than monitoring the effects after they occur. Shell has committed to implement the following operational standards as part of the Project:

- the cogeneration units will meet the Canadian Council of Ministers of the Environment (CCME) emission criteria for stationary combustion turbines and AENV's *Alberta Air Emission Standards for Electricity Generation*. The cogeneration units and auxiliary boilers will also meet AENV's *Emission Guidelines for Oxides of Nitrogen (NO_x) for New Boilers, Heaters and Turbines using Gaseous Fuels Based on a Review of Best Available Technology Economically Achievable (BATEA) – Interim Guideline.*

- the following emissions control efficiencies will be implemented for the asphaltene-fired cogeneration units:

MITIGATION, MONITORING AND MANAGEMENT (cont'd)

  - SO_2 control efficiency of 99%
  - NO_x control efficiency of 75%
  - PM control efficiency of 99.97%

- above-ground storage tanks will conform to CCME's *Environmental Guidelines for Controlling Emissions of Volatile Organic Compounds from Above-Ground Storage Tanks*

- plant-wide fugitive emissions will be identified and controlled using the protocol recommended by the Canadian Association of Petroleum Producers' (CAPP) *Management of Fugitive Emissions at Upstream Oil and Gas Facilities*, as well as other relevant guidelines and codes of practice aimed at reducing fugitive emissions

- flaring will be limited to upset and emergency conditions, start-up and commissioning, and will comply with EUB Directive 060

- vehicles in the mine fleet will meet the emission standards applicable at the time of purchase

- mine maintenance procedures will ensure that fleet vehicles are regularly maintained

- tailings solvent recovery unit (TSRU) tailings deposition will be managed to maintain an annual average rate of four volumes of solvent per 1,000 volumes of bitumen produced

- slash burning will be managed according to Shell's Environmental Management System procedure and by continuing to coordinate slash burning with other operators in the region

- road dust will be managed during construction and operations by watering the roads during dry periods

Shell is an active participant in ongoing environmental management initiatives in the oil sands region, including initiatives focused on regional air quality. Shell is committed to continuing participation in these initiatives, by:

- continuing active participation in the Wood Buffalo Environmental Association (WBEA) and the Terrestrial Environmental Effects Monitoring (TEEM) program for matters relating to monitoring and assessing air emissions in the oil sands region. Shell will work with AENV and WBEA members to understand regional monitoring requirements.

- meeting the requirements of the:

  - Acidification Management Framework, developed through the NO_x–SO_2 Management Working Group of CEMA

  - Trace Metals Management Framework, developed through the Trace Metals and Air Contaminants Working Group (TMAC) of CEMA

- adhering to its Health, Safety and Environment Plan and the ISO 14001 certified Environmental Management System

Shell has been a participant in air quality monitoring in the oil sands region since 2000. As part of the Project, Shell is proposing to incorporate the following source and ambient monitoring activities, determined in consultation with WBEA and AENV:

- conducting stack surveys and sampling on new boilers and heaters, consistent with Shell's current approval conditions under the EPEA

- expanding the existing leak detection and repair program to detect, measure and control emissions from equipment leaks from new facilities, according to CAPP's *Management of Fugitive Emissions at Upstream Oil and Gas Facilities*

- continuing to monitor VOCs through grab samples at ambient trailers, according to WBEA requirements

- continuing to conduct fugitive emission surveys on the external tailings disposal area (ETDA) and mine surfaces on site, and at ambient trailers, to quantify and speciate (categorize) VOCs and TRS compounds by source

NOISE

SCOPE OF ASSESSMENT

The noise assessment considered the effects that activities associated with the Project and existing and approved developments would have on local noise levels and nearby dwellings. The noise assessment focused on evaluating noise levels at discrete receivers near the Project, as required by EUB Noise Control Directive (Directive 038), and according to the requirements of the EIA Terms of Reference.

Noise levels were predicted for periods when the Project activities were at the closest point to key receivers for both the Jackpine Mine Expansion and the Pierre River Mine areas. Base Case and Application Case noise predictions were made using the CadnaA noise model and available regional information. The potential effects of noise on wildlife were assessed in EIA Volume 5, Section 7.

SUMMARY OF RESULTS

The assessment found that noise impacts from the Jackpine Mine Expansion area were negligible. In addition, noise levels at the Jackpine mine construction camp (Albian Village) and the Pierre River Mine construction camp (Pierre River Village) were assessed as being acceptable, based on Health Canada guidelines (see EIA Volume 3, Appendix 3-11).

The Pierre River Mine, cumulatively with the existing and approved facilities, is predicted to result in no change in noise levels at two receivers, referred to as NR3 and NR4 in the EIA. A change in noise levels as a result of the Pierre River Mine is predicted to occur at a third receiver, referred to as NR2 in the EIA, and at the 1.5 km boundary for the Pierre River Mine area. The noise levels at receiver NR2 are within the permissible sound level (PSL) guidelines, whereas the noise levels at the Pierre River Mine area 1.5 km boundary are predicted to exceed the permissible sound level.

The predicted noise levels at receiver NR2 result in a low environmental consequence because they are above Base Case levels. The predicted change primarily results from the Pierre River Mine ETDA. Bird deterrent cannons at the ETDA will generate intermittent noise that might result in a measurable change in ambient noise levels at the NR2 receptor. However, the Project's noise levels will comply with the permissible sound level for this location. The cannons are unlikely to be audible at receiver NR2 because a 3 dBA change in noise level is the general threshold at which changes are noticeable for humans.

SUMMARY OF RESULTS (cont'd)

The analysis indicated that noise levels would exceed the permissible sound level along sections of the Pierre River Mine 1.5 km boundary, but the increase is predicted to have only a moderate environmental consequence.

The primary sources of noise from the Pierre River Mine area at the 1.5 km boundary are the:

- plant site facilities
- bird deterrent cannons at the ETDA

Noise control design to address the non-compliance for the plant site facilities will be determined during detailed design, as required by EUB Directive 038. Mitigation controls for the plant site could range from procuring low noise equipment, to providing enclosures and silencers, depending on the equipment requiring control. Regarding bird cannons, the assessment is considered conservative because of the assumed duration of the modelled sound emissions, so impacts will be verified before considering mitigation. In addition, an operational noise management plan outlining monitoring and mitigation options will be developed to address potential noise issues at the Pierre River Mine.

Although permissible sound levels were exceeded at receivers N3 and N4 in the Base Case as a result of a neighbouring project, the Jackpine Mine Expansion and Pierre River Mine Project do not increase the predicted noise levels at those locations.

Although not specifically required by the Terms of Reference, the effects of traffic and construction noise were reviewed. The effects of these sources are expected to be negligible.

The assessment of the potential effects of noise on wildlife indicated that the assessed wildlife species affected by noise will habituate to the disturbance effects of the Project. The magnitude of the effects was predicted to be negligible (see EIA Volume 5, Section 7.5).

MITIGATION, MONITORING AND MANAGEMENT

Several Project design features to mitigate noise were considered in the noise assessment. These design features include:

- using bird-activated deterrent cannon systems at the ETDAs that trigger when birds are in the area, rather than firing continuously

- providing fixed equipment with any necessary noise control to meet the *Alberta Occupational Health and Safety Act* (OHS) design requirements

Despite these design considerations, additional noise mitigation will be required. An operational noise management plan will be developed and implemented

during detailed design to address the potential for moderate magnitude impacts. The operational noise management plan will include:

- monitoring for noise effects at receivers, including tonal and low frequency noise, if monitoring is conducted at receivers NR3 and NR4
- producing a detailed acoustic design for the Pierre River Mine plant equipment
- analyzing the bird deterrent system for the Pierre River Mine ETDA to verify the impacts, and conducting a follow-up discussion with the EUB, if required

Potentially affected parties will be consulted during Project construction and operations regarding noise levels.

HUMAN HEALTH RISK ASSESSMENT

Assessment Results

Emissions from the Project alone, and in combination with other sources of chemicals of potential concern (COPC), are not expected to result in a noticeable increase in health risks in the oil sands region. As the changes between the Base Case and Application Case health risks are generally small, the Project is not predicted to contribute appreciably to health risks in the oil sands region. Similarly, the changes in health risks from the Base Case to the Planned Development Case are small. Therefore, cumulative health risks associated with the additional Project and activities planned for the region are not expected to result in a measurable increase in health effects.

Acute Inhalation Health Risks

Acute health risks associated with the air emissions from the Project were characterized by comparing predicted maximum short-term air concentrations with health-based guidelines considered protective of the most sensitive individuals.

Predicted short-term air concentrations were less than the health-based guidelines for most of the COPC. The only exceptions were acrolein, $PM_{2.5}$, the eye irritant mixture and the respiratory tract irritant mixture. Predicted exceedances for acrolein, the eye irritant and respiratory tract irritant mixtures resulted from the human health risk assessment being conservative.

Only a slight exceedance (risk quotient of 1.1) of the 24-hour Canada-wide standard for $PM_{2.5}$ was predicted for transient people at the Jackpine Mine Expansion fenceline. The potential for adverse health effects associated with short-term exposure to $PM_{2.5}$ as a result of the Project is low, because:

- the predicted exceedance was localized to the Project fenceline
- no changes in the likelihood of an exceedance or potential health risks were associated with the Project
- the predicted annual average $PM_{2.5}$ concentrations were sufficiently low to provide supplemental protection against episodic localized or seasonal peaks of $PM_{2.5}$

Chronic Inhalation Health Risks

Chronic health risks associated with the Project's air emissions were characterized by comparing predicted annual average concentrations, including measured or background indoor air concentrations, with health-based guidelines considered protective of the most sensitive individuals.

The predicted long-term air concentrations met the health-based guidelines for most COPC. Exceedances were predicted for acrolein, hydrogen sulphide and the nasal irritant mixture. Only a slight exceedance (risk quotient of 1.1) was predicted for hydrogen sulphide, for the workers living at the Pierre River Mine construction camp. Predicted exceedances associated with acrolein and the nasal irritant mixture were more substantial. However, these levels were associated entirely with the assumed background indoor exposure or Base Case exposure. As no appreciable difference exists between the Base Case and Application Case, risk estimates for these COPC, the Project's contribution to predicted chronic health risks in the oil sands region, is negligible.

Chronic Multiple Pathway Health Risks

The health risks associated with multiple pathways of exposure, i.e., inhalation, ingestion and dermal contact, were assessed. The predicted exposures met the health-based guidelines, except for:

- methyl mercury
- molybdenum
- the neurotoxicant mixture
- the reproductive and developmental toxicant mixture

Exceedances associated with the neurotoxicants and reproductive and developmental toxicants were almost entirely the result of the predicted methyl mercury exceedances.

The methyl mercury exceedances were predicted entirely on the basis of fish consumption in the Base Case. No changes were predicted in the risk estimates between the Base, Application and Planned Development cases. The potential health risks for methyl mercury were likely driven by the conservative assumption that residents will obtain all of the fish they consumed from local waterbodies, and will not supplement their diet with fish from local supermarkets. Therefore, potential health risk estimates predicted for the neurotoxicants and reproductive and developmental toxicants were conservative.

In addition to the three development cases outlined in the Terms of Reference, health risks were predicted for consumption of fish from pit lakes after Project operations. Exceedances were predicted for:

- methyl mercury
- molybdenum
- the neurotoxicant mixture
- the reproductive and developmental toxicant mixture
- arsenic

These exceedances represent a strictly hypothetical calculation because of the conditions that were assumed.

Shell's commitment to extensive ongoing monitoring of the region's water quality will help to ensure the protection of both the environment and human health from these predicted health risks.

WILDLIFE HEALTH RISK ASSESSMENT

Assessment Results

The Wildlife Health Risk Assessment was a conventional risk assessment, but the worst-case conditions were emphasized to ensure that risks were not underestimated. The findings and conclusions were based on the conservative assumptions incorporated into the assessment.

The assessment found that:

- in all cases, except for NO_2, maximum predicted acute and chronic COPC concentrations in the air were below the levels that affect wildlife populations adversely. Exceedances associated with NO_2 were observed for the Base Case, Application Case and Planned Development Case on a chronic basis. The risk estimates are likely the result of the conservative assumptions in the risk assessment. The maximum predicted ground-level air concentrations for NO_2 were below the levels that affect wildlife, according to scientific literature.

- maximum predicted COPC concentrations in soil, vegetation, water and prey were below the levels that affect wildlife populations adversely, except for concentrations of:

    - aluminum
    - antimony
    - manganese
    - mercury (inorganic and organic)
    - vanadium

- the risk estimates largely result from the measured concentrations used in the exposure assessment, which fall within or below the range of measured background concentrations reported in the literature

- little to no change exists between:

    - the Base Case and Application Case risk estimates, indicating that the Project is not expected to contribute to potential adverse wildlife health effects

    - the Base Case and Planned Development Case risk estimates, indicating that the contribution of future projects to wildlife health effects in the oil sands area is expected to be minimal

Mitigation, Monitoring and Management

Many regional initiatives address human health issues in the oil sands region. Shell is currently an active participant in the following regional monitoring programs, which collect air and water quality information that can be used to assess potential human health risks:

- Regional Aquatics Monitoring Program (RAMP) – Shell will attempt to reduce the uncertainty surrounding the predicted mercury concentrations in water and fish through its ongoing participation in RAMP
- Cumulative Environmental Management Association (CEMA) End Pit Lake Task Group – Shell, in cooperation with AENV and other regulatory agencies, will:
  - determine the parameters to be used for assessing pit lakes and the potential effects on human health
  - manage access to pit lakes if aquatic health might pose a threat to human health

For additional mitigation measures related to air, see EIA Volume 3, Section 3.2. For those related to water quality, see EIA Volume 4, Section 6.5.

AIR EMISSIONS EFFECTS ON ECOLOGICAL RECEPTORS ASSESSMENT

The Air Emissions Effects on Ecological Receptors assessment considered potential effects on aquatic and terrestrial resources. Air emissions were predicted within the air quality modelling domain (see EIA Volume 3, Section 3.2). Aquatic resources were assessed within waterbodies in the air quality modelling domain. Terrestrial resources were assessed within the terrestrial resources air emissions effects study area.

The incremental addition of the Project's air emissions in the region does not contribute to the potential effects on ecological receptors. All environmental consequences related to the Project are rated as negligible.

Aquatic Resources

The assessment of the effects of air emissions on aquatic systems and biota consisted of assessing the:

- sensitivity of lakes and streams in the air quality modelling domain to acid deposition
- potential effects of Base Case air emissions
- potential effects of the Project, in combination with existing sources

- need to evaluate Project effects combined with existing, approved and planned regional developments

Under the Base Case, net PAI levels in lakes are at, or above, the lake-specific critical loads for 21 of the 413 lakes in the assessment. The background lake net PAI is above the critical load for 18 of these lakes. These results suggest that a few lakes in the air quality modelling domain might be at risk of acidification under the Base Case, and in some cases under background conditions.

Project emissions are not predicted to result in additional exceedances of the critical load under the Application Case, and increases in acid deposition to lakes with baseline exceedances are small (less than 5%). Therefore, Project emissions are predicted to have a negligible potential to affect water quality or aquatic life in regional lakes.

The increase in regional emissions as a result of the Project and changes in snowmelt pH are predicted to have a negligible potential to affect episodic stream acidification.

Shell will continue its participation in RAMP to ensure that monitoring continues in regional lakes for potential changes as a result of acid deposition.

Soils

The assessment of air emissions effects on soils, and the related indirect effects on vegetation, consisted of assessing:

- Base Case soil critical loads within the terrestrial resources air emissions effects study area
- potential soil critical load exceedances as a result of the Project, in addition to the Base Case
- the need to evaluate soil critical load exceedances as a result of the Project and existing, approved and other planned developments in the region

The soil assessment methods follow the CEMA approach for calculating soil critical load exceedances. This includes assessing critical load exceedances for all soils in watersheds of lakes that exceeded lake critical loads.

Under the Base Case, 1,836 ha of soil (less than 1% of the terrestrial resources air emissions effects study area) receive soil net PAI in excess of their critical loads. Exceedances are generally centred over existing developments in the terrestrial resources air emissions effects study area.

Under the Application Case, 1,829 ha of soil (less than 1% of the terrestrial resources air emissions effects study area) are expected to receive PAI in excess of their critical loads. A reduction of 7 ha (less than 1% of the terrestrial resources air emissions effects study area) in the areas of soil potentially affected by acidification is predicted between the Base Case and Application Case in the

Soils (cont'd)

terrestrial resources air emissions effects study area. This is attributed to the modelled shift of the Jackpine Mine fleet to the north part of the mine, rather than to decreases in emissions. As vegetation is the ultimate receptor of soil acidification, changes to soil quality are considered in the environmental consequence to terrestrial vegetation and wetlands, where effects of the Project are rated as negligible.

Terrestrial Vegetation and Wetlands

The assessment of air emissions effects on terrestrial vegetation and wetlands consisted of assessing the:

- predicted Base Case air concentrations in the region, using existing deposition rates, concentrations and areal extent
- potential impacts of the Project together with the Base Case
- need to evaluate the potential impacts of the Project and other planned developments in the region

All potential effects, both indirect and direct, as a result of the relative contribution of the Project, are considered to be negligible for terrestrial vegetation and wetlands, including wildlife habitat.

Under the Base Case, about 1,780 ha of vegetation (1% of vegetated portions of the terrestrial resources air emissions effects study area) are potentially affected by the indirect effects of PAI. In the Application Case, the area potentially affected by PAI decreases by 7 ha (less than 1% of the vegetated areas). This decrease is attributed to the shift of the Jackpine Mine fleet to the north part of the mine, rather than to decreases in emissions (see EIA Volume 3, Section 5.5).

The direct effects of SO_2, NO_2 and eutrophication deposition under the Base Case will potentially affect only a limited portion (less than 1%) of the vegetated portions of the terrestrial resources air emissions effects study area.

Under the Application Case, neither SO_2 concentrations, nor the areal extent of vegetated areas potentially affected by SO_2, increase as a result of the Project. The area containing annual levels above 10 $\mu g/m^3$, the World Health Organization (WHO) guideline for lichens, increases by 7 ha as a result of the Project. This is less than 1% of the vegetated portions of the terrestrial resources air emissions effects study area.

The extent of vegetated areas potentially affected by NO_2 do not increase as a result of the Project, and remain unchanged from the Base Case. The area of the treed bog/poor fen class potentially negatively affected by eutrophication (above 2 keq N/ha/a) might increase by 2 ha as a result of the Project. This is less than 1% of the terrestrial resources air emissions effects study area.

For both the Base and Application cases, the effect of ozone on terrestrial vegetation and wetlands is predicted to be negligible.

Mitigation, Monitoring and Management

For a discussion of Shell's commitment to mitigation, monitoring and management of project air emissions and their effects, see EIA Volume 3, Section 3.2.

SCOPE OF ASSESSMENT

The effects of the Project and the existing, approved and planned developments, were assessed on hydrogeology (groundwater) in the study areas during project operations and closure and the far future.

SUMMARY OF RESULTS

Jackpine Mine Expansion

Mine development at the Jackpine Mine Expansion will result in water table drawdown in the surficial deposits. The drawdown will extend generally less than 2 km, but locally up to 3.5 km, from the mining area. The drawdown will result in reduced groundwater discharge to the Muskeg River during mine development. Reduced groundwater discharge to the Muskeg River is also predicted in the closure landscape because of the altered topography and drainage patterns.

The reduced base flow to the Muskeg River will be offset by base flow to the northeast and northwest pit lakes. Drawdown in the overburden deposits between 0.1 to 1 m might extend up to 1 km from the southern edge of the lenticular patterned fen north of the project development area.

Seepage from the Jackpine Mine Expansion ETDA will lead to reduced groundwater quality and seepage to the northeast and northwest pit lakes. Seepage from the Jackpine Mine – Phase 1 ETDA will be captured and recycled. Mine pit backfilling will lead to reduced groundwater quality and plume migration towards the Athabasca River through a basal aquifer pathway. Travel times are predicted to be in the order of hundreds of years, and seepage rates are predicted to be negligible compared to Athabasca River flow rates.

Pierre River Mine

Mine development at the Pierre River Mine will result in water table drawdown in surficial deposits. The drawdown will extend from about 1 to 5 km from the mining area. The drawdown will result in reduced groundwater discharge to the Pierre River during mine development. Reduced groundwater discharge to the Pierre River is also predicted in the closure landscape because of the altered topography and drainage patterns. The reduced base flow to the Pierre River will be offset by base flow to the Pierre River Mine north and south pit lakes.

Pierre River Mine (cont'd)

Seepage from the ETDA will lead to reduced groundwater quality and seepage to Big Creek and the Athabasca River valley. Mine pit backfilling will lead to reduced groundwater quality and seepage to the Athabasca River and the north and south pit lakes. Groundwater seepage to the pit lakes will be treated before being discharged to surface water drainage. Seepage volumes to the Athabasca River are predicted to be negligible compared with Athabasca River flows.

Athabasca River

The Project will have some minor influence on groundwater discharge to the Athabasca River because of the proximity of the Pierre River Mine. However, this effect is negligible when compared with flow in the Athabasca River.

BASE CASE

Jackpine Mine Expansion

The Base Case developments within the local study area include:

- Shell's Muskeg River Mine and Muskeg River Mine Expansion
- Syncrude's Aurora North and South mines
- Shell's Jackpine Mine – Phase 1
- Fort Hills Energy Corporation's Fort Hills Oil Sands Project
- Imperial's Kearl Oil Sands Project, including Husky's Sunrise wells on the Kearl lease

The Base Case developments will affect the basal aquifer. Maximum drawdowns of about 50 m to 80 m are expected along the Jackpine Mine Expansion southern lease boundary around 2033. By the end of mining in 2052, drawdown as a result of the existing and approved facilities will decrease to less than 10 m, except along the boundary with the Kearl Oil Sands Project. There, drawdown in the basal aquifer could remain about 50 m because of ongoing mine development.

Dewatering of the Pleistocene channel aquifer for mine development at Jackpine Mine – Phase 1 and the Kearl Oil Sands Project will cause drawdown of less than 20 m in an area up to 2 km from the southeastern boundary of the Jackpine Mine Expansion local study area. By 2052, no residual drawdown in the Pleistocene channel aquifer is predicted because of the existing and approved facilities.

Maximum drawdown effects in the Jackpine Mine local study area because of dewatering of Quaternary deposits at the adjacent Aurora South and Kearl Oil Sands Project mining areas are expected to be about 20 m within an area 1 to 3 km from the Jackpine Mine Expansion pit limits. No residual overburden dewatering effects are predicted for the Jackpine Mine Expansion local study area after dewatering ceases at the Aurora South and Kearl Oil Sands Project mining areas by 2065.

Overburden and Pleistocene channel aquifer dewatering and basal aquifer depressurization at existing and approved facilities will cause a decrease in groundwater discharge to the Muskeg River of up to 160 L/s around 2033, and reduced base flow to Jackpine Creek of about 50 L/s (in 2012 and 2033 snapshots). Seepage from McClelland and Kearl lakes to groundwater will not be affected by the Base Case.

Pierre River Mine

The Canadian Natural Resources Limited (Canadian Natural) Horizon Oil Sands Project (Horizon Project) is the closest oil sands project to the Pierre River Mine. Other projects are located south of the Horizon Project or across the Athabasca River.

Basal aquifer drawdown as a result of depressurization at the Horizon Mine will not extend outward to the Pierre River Mine area. No effects of depressurization of the basal aquifer from existing and approved facilities located east of the Athabasca River are predicted at the Pierre River Mine.

Water table drawdown of more than 1 m as a result of overburden dewatering at the Horizon Project is predicted to remain more than 6 km away from the Pierre River Mine area.

Overburden dewatering and basal aquifer depressurization at the Horizon Project will cause a decrease in groundwater outflow to surface water resources within the Pierre River Mine local study area. However, these effects are constrained to the Calumet River basin and areas farther south. Groundwater discharge to the Pierre River and surface waters farther north are not affected by the Base Case.

Athabasca River

Existing and approved developments might cause decreases in groundwater discharge to the Athabasca River of up to 30 L/s between the confluences with the Muskeg River and the Pierre River, and of up to 10 L/s north of the Pierre River. For comparison, the estimated 7Q10 low flow for the Athabasca River below the Muskeg River is 103,000 L/s (103 m^3/s). Thus, the predicted effect is less than 0.02% of the 7Q10 low flow, which is negligible.

APPLICATION CASE

Jackpine Mine Expansion

The basal aquifer depressurization rates in the Jackpine Mine Expansion area will range from 4 to 50 L/s and be about 40 to 50 L/s during maximum development (2034 to 2052). Basal aquifer depressurization will cause drawdowns of 60 to 80 m within the Jackpine Mine Expansion local study area. Although the effects of basal aquifer depressurization will be mostly confined to the lease area, drawdowns will extend farther to the west and south, because of greater continuity of the basal aquifer in these directions. By 2065, only minor residual

Jackpine Mine Expansion (cont'd)

drawdown will exist in the basal aquifer because of Jackpine Mine Expansion area depressurization in the northwest part of the lease.

Between 2037 and 2051, when Pleistocene channel aquifer dewatering will be required at the Jackpine Mine Expansion area, annual dewatering rates will range from 30 to 320 L/s, with an average of 140 L/s. Around 2052, Pleistocene channel aquifer dewatering at the Jackpine Mine Expansion area will cause a drawdown of up to about 30 m. By 2065, no residual drawdown of groundwater levels will occur in the Pleistocene channel aquifer as a result of the Jackpine Mine Expansion.

The average annual overburden dewatering rate for the Jackpine Mine Expansion will be about 80 L/s, but higher annual rates of between 120 and 300 L/s are predicted between 2045 and 2051. Maximum drawdown because of overburden dewatering will be about 10 to 20 m in the southern portion of the local study area, and about 30 m in the northwestern portion. By 2065, no residual drawdown will exist as a result of overburden dewatering at the Jackpine Mine Expansion.

The maximum extent of dewatering effects in the overburden materials was conservatively estimated by simulating the entire mining footprint simultaneously. Dewatering effects are generally confined to the Jackpine Mine Expansion local study area, but extend about 3.5 m to the west. Predicted maximum drawdowns are about 1 m at the southern edge of the lenticular patterned fen, and decrease to 0.1 m within about 1 km from the fen's edge. No effects are predicted for the lenticular patterned fen.

Simulated pit highwall seepage rates are about 20 L/s in 2033 and 130 L/s in 2052. The higher rate simulated for 2052 reflects the larger pit floor area and proximity to upgradient unmined areas near the mine boundaries.

During operations, estimated seepage from the Jackpine Mine Expansion ETDA will be about 240 L/s once the tailings facility is at capacity. Upon closure, following capping and reclamation, estimated seepage will be about 20 L/s. Seepage from the ETDA to Quaternary deposits will be intercepted and returned to the tailings facility during operations as part of tailings management. Seepage from the Jackpine Mine – Phase 1 ETDA will be captured and recycled.

Groundwater discharge to the Muskeg River downstream of the Jackpine north pit lake and Muskeg Creek is predicted to decrease by about 100 L/s compared with pre-development conditions during operations. In the closure landscape, total groundwater discharge to the Muskeg River will remain below pre-development flow levels by about 100 L/s. This reduction in groundwater discharge to the Muskeg River will be offset by base flow to the Jackpine northeast and northwest pit lakes, which will be introduced in the closure landscape.

The groundwater quality simulations considered the following six parameters, which represent a range of dissolved compound behaviours, including conservative (non-retarded, non-degradable), retarded and degradable:

- total dissolved solids (TDS)
- barium
- naphthenic acids
- carcinogenic polycyclic aromatic hydrocarbons (PAHs)
- non-carcinogenic PAHs
- chronic toxicity

In the surficial deposits, effects on groundwater quality will be limited within the local study area to the area east of the Muskeg River and south of the northeast and northwest pit lakes. The Pleistocene channel aquifer might act as a preferential pathway for solute migration, which might be enhanced by dewatering at the Kearl and Aurora South mines. Seepage from the ETDA will lead to reduced groundwater quality and seepage to the northeast and northwest pit lakes.

Mine pit backfilling will lead to reduced groundwater quality and plume migration towards the Athabasca River through a basal aquifer pathway. By 2165, conservative substances within the groundwater plume in the basal aquifer might have reached 1 km west of the confluence of Jackpine Creek and the Muskeg River.

Pierre River Mine

The basal aquifer depressurization rates in the Pierre River Mine area will range from 10 to 40 L/s and will be highest around the time of maximum development (2029 to 2032). Depressurizing the basal aquifer will cause drawdowns of 50 to 60 m. Drawdown will mostly be limited in lateral extent to the Pierre River Mine area and immediate vicinity. By 2049, basal aquifer groundwater resources in the area of the Pierre River Mine will have recovered to pre-development conditions.

Estimated annual overburden dewatering rates for the Pierre River Mine area vary from about 1 to 90 L/s. Dewatering rates are generally highest for areas near the western perimeter of the mine and lowest for areas on the east side of the mine. Maximum drawdown as a result of overburden dewatering is estimated at up to 30 m. In 2049, no residual drawdown will exist as a result of overburden dewatering at the Pierre River Mine.

The maximum extent of dewatering effects in the overburden materials was conservatively estimated by simulating the entire mining footprint simultaneously. Dewatering effects are generally confined to an area from less than 1 km to about 3 km west from the mine pit limits and up to 5 km north and south of the mine.

Simulated pit highwall seepage rates are about 50 L/s in 2031 and 10 L/s in 2039. The higher rate for 2031 reflects the proximity to upgradient unmined areas.

Pierre River Mine (cont'd)

During operations, estimated seepage from the Pierre River Mine ETDA is about 240 L/s once the tailings facility is at capacity. Upon closure, following capping and reclamation of the ETDA, the estimated seepage is about 30 L/s. Seepage from the ETDA to Quaternary deposits will be intercepted and returned to the tailings facility during operations as part of tailings management.

Groundwater discharge to the Pierre River is predicted to decrease by about 40 to 50 L/s compared with pre-development conditions during operations. In the closure landscape, total groundwater discharge to the Pierre River is predicted to remain below pre-development flow levels by about 30 L/s. This reduction in groundwater discharge to the Pierre River will be offset by base flow to the Pierre River Mine north and south pit lakes, which will be introduced in the closure landscape.

The groundwater quality simulations considered the following six parameters that represent a range of dissolved compound behaviours, including conservative (non-retarded, non-degradable), retarded and degradable constituents:

- total dissolved solids
- barium
- naphthenic acids
- carcinogenic PAHs
- non-carcinogenic PAHs
- chronic toxicity

Seepage from the ETDA will lead to reduced groundwater quality and seepage to Big Creek and the Athabasca River valley. Mine pit backfilling will lead to reduced groundwater quality and seepage to the Athabasca River and the north and south pit lakes. Seepage from tailings Cells 1 and 3 will migrate predominantly towards the pit lakes, whereas seepage from Cell 2 will migrate towards the Athabasca River valley through both shallow groundwater and basal aquifer pathways.

Athabasca River

The Project might cause an additional decrease in groundwater discharge to the Athabasca River of up to 10 L/s north of the confluence with the Pierre River, because of the proximity of the Pierre River Mine. This is less than 0.02% of the estimated 7Q10 low flow for the Athabasca River, and is considered negligible.

MITIGATION, MONITORING AND MANAGEMENT

Operations

The Project's water management plans (see Section 10) include various design features, mitigation measures and best management practices to limit the effects on groundwater. The mitigation measures that Shell will implement include:

- intercepting, capturing and recycling seepage from:
  - the ETDAs
  - backfilled cells through the closed-circuit drainage system
- returning groundwater dewatered from overburden materials and the Pleistocene channel aquifer to surface waterbodies
- using low-permeability overburden material to isolate non-segregating tailings backfill from Quaternary sand and gravel deposits

Shell will implement a groundwater monitoring program to monitor the effects of the Project as a result of basal aquifer depressurization and dewatering of the overburden materials, including the Pleistocene channel aquifer. The monitoring program will include monitoring the effects on overburden groundwater quality as a result of ETDA operations, pit backfilling, and plant facilities. For the groundwater monitoring program developed for the Project, see EIA Volume 4, Appendix 4-9.

Closure

The closure topography and drainage systems for the Project will be designed with the equivalent capability to similar natural systems. Overall, groundwater flow in the reclaimed landscape will be directed from topographically high areas towards topographically low areas, where groundwater will discharge to wetlands and pit lakes and streams. Seepage from the capped and reclaimed ETDAs will be intercepted by perimeter ditches and routed through wetlands before being released to the environment.

The groundwater monitoring program will provide confirmation of the predicted effects and the recovery of groundwater levels to similar pre-development conditions as mining areas are reclaimed.

Shell is an active participant in the Athabasca Oil Sands Regional Groundwater Monitoring Program, which is currently being developed under AENV's direction.

SCOPE OF ASSESSMENT

The effects of the Project and the existing, approved and planned developments, were assessed on surface water hydrology in the study areas during operations and closure.

SUMMARY OF RESULTS

Jackpine Mine Expansion

During operations in 2052, the Jackpine Mine Expansion will result in a maximum reduction of the total open-water area within the local study area by up to 20.2 km^2 from Base Case conditions. At closure, the total open-water area in the local study area will increase as a result of the Jackpine Mine Expansion by about 29.2 km^2.

Jackpine Creek flow will not be affected by the Jackpine Mine Expansion. Integrating the Aurora South Mine and Jackpine Mine – Phase 1 will cause changes in the mean annual flow levels in Jackpine Creek. Changes as a result of the Jackpine Mine Expansion will be less than 10% for the Base Case and less than 11% for the Application Case. During muskeg drainage and overburden dewatering activities in 2012, the Muskeg River mean annual flow will increase by up to 1.4% as a result of Jackpine Mine Expansion activities. The maximum reduction in mean annual flow will be about 0.31 m^3/s (8.3%), as a result of Jackpine Mine Expansion closed-circuit operations. At closure, the mean annual flow in the lower Muskeg River is expected to be higher than the pre-development value by about 9%.

The Jackpine Mine Expansion and drainage integration will result in changes to Kearl Lake water levels compared with pre-development conditions. The Jackpine Mine Expansion will also result in negligible changes in basin sediment yields, and total suspended concentrations in the receiving streams.

Pierre River Mine

The Pierre River Mine will result in an increase in the total open-water area within the local study area during operations and at closure. At closure, the total open-water area will increase by about 21 km^2.

Pierre River Mine (cont'd)

The Pierre River Mine will also cause changes in the mean annual flow levels, compared with pre-development levels, in the Pierre River, Eymundson Creek and Big Creek, as follows:

- the mean annual flow levels in the Pierre River will be reduced from 6.8% during mine operations to 13.8% at mine closure
- the mean annual flow levels in Eymundson Creek will increase during mine operations by less than 3%. During mine closure, the mean annual flow will be reduced by about 16%.
- the mean annual flow levels in Big Creek will change by about 4.2% during mine operations and decrease by about 8.5% at closure

The Pierre River Mine will also result in negligible changes in basin sediment yields, and total suspended solids concentrations in the receiving streams.

BASE CASE

Jackpine Mine Expansion

The Base Case developments within the local study area include the:

- Muskeg River Mine and Muskeg River Mine Expansion
- Aurora North and South mines
- Jackpine Mine – Phase 1
- Kearl Oil Sands Project

These projects have caused, or will cause, changes to the hydrologic conditions of Kearl Lake, Jackpine Creek and the Muskeg River.

The Base Case developments will cause an increase in the total open-water area within the local study area of up to 23.4 km^2 during operations. At closure, the total open-water area in the local study area will increase by about 80.3 km^2.

The Base Case developments will cause small changes in the mean annual flow levels in Jackpine Creek and negligible change to the Kearl Lake water level. During mine operations in 2052, the mean annual flow in the Muskeg River will be reduced by as much as 16.2%, compared with pre-development flow levels.

The Base Case developments will require water withdrawal from the Athabasca River, and this will affect flow levels in the Athabasca River. The reduction in mean seasonal Athabasca River flow levels as a result of withdrawals for Base Case developments is predicted to range from 1.8% in summer to 12.1% in winter, based on average Athabasca River weekly flow levels.

The Base Case developments will also result in negligible changes in basin sediment yields and concentrations of total suspended solids in the receiving streams.

Pierre River Mine

No existing or approved oil sands projects occur in the watersheds of the tributary streams to the Athabasca River in the Pierre River Mine local study area. However, the operational and closure diversion channel of the Horizon Project will be routed through the south corner of the Pierre River watershed and will cause a negligible reduction in mean annual flow levels at the mouth of the river.

APPLICATION CASE

The hydrologic assessments for the effects of the Project, plus existing and approved developments, included considering:

- open-water areas
- flow and water levels in the receiving streams and waterbodies
- sediment yields and channel regimes of receiving streams

Jackpine Mine Expansion

The Application Case developments will cause a decrease in the total open-water area within the Jackpine Mine Expansion local study area of up to 20.2 km^2 during operations compared with the Base Case. At closure, the total open-water area in the local study area will increase by about 29.2 km^2 compared with the Base Case.

Integrating operational and closure drainage plans will cause negligible changes in the mean annual flow levels in Jackpine Creek and to the water levels at Kearl Lake. The mean annual flow in the Muskeg River will be reduced by as much as 24.5% during mine operations in 2052, and the Jackpine Mine Expansion area will account for 8.3%. At closure, the mean annual flow at the mouth of the Muskeg River will increase by 9.4% compared with pre-development, and the Jackpine Mine Expansion area will account for 3.4%.

The Application Case developments will also result in negligible changes in basin sediment yields and concentrations of total suspended solids in the receiving streams.

Pierre River Mine

During operations, the Pierre River Mine will cause an increase in the total open-water area within the local study area of up to 1.2 km^2. At closure, the total open-water area in the local study area will increase by about 21 km^2 as a result of the Pierre River Mine.

Pierre River Mine (cont'd)

The Pierre River Mine area will cause small reductions in the mean annual flow levels in Big Creek and Eymundson Creek of less than:

- 5% during mine operations
- 7% after mine closure

The Pierre River Mine will also result in negligible changes in basin sediment yields, and small changes in channel regimes and concentrations of total suspended solids in the receiving streams.

The Pierre River Mine will require water withdrawal from the Athabasca River, and this will affect flow levels in the Athabasca River. The reduction in mean seasonal Athabasca River flow levels as a result of water withdrawals for Application Case developments ranges from 2.1% in summer to 14.1% in winter, based on average Athabasca River weekly flow levels. The Pierre River Mine will account for a reduction in Athabasca River weekly flow levels of between 0.3% in summer to 1.8% in winter.

MITIGATION, MONITORING AND MANAGEMENT

Operations

Shell will modify the existing network of flow and water level monitoring stations to include the Jackpine Mine Expansion area.

The Project's water management system during operations is based on the requirement that all water from the plant site and areas in contact with the oil sands will be contained within the project development area. Closed-circuit operations are planned to start at the beginning of operations.

Shell will limit sediment loading to receiving streams and lakes by routing water from muskeg drainage and overburden dewatering to polishing (sedimentation) ponds, before releasing the water to receiving streams. Ponds will be equipped with oil separation capability, where required.

Closure

Erosion protection measures will be taken to reduce the erosion of embankments and the raw water storage facilities during floods.

Management and Research

The task groups of the Surface Water Working Group (SWWG) of CEMA are addressing several surface water quality issues in the oil sands region, including the:

- instream flow needs in the lower Athabasca River
- the integrity of regional drainage basins

Shell will continue its active participation in, and support for, CEMA as well as its working task groups.

SCOPE OF ASSESSMENT

This subject summarizes the surface water and sediment quality assessment for the Project. The potential effects of Project activities on increases in constituent concentrations or changes required to comply with aquatic life guidelines are assessed.

Based on water and sediment quality predictions for receiving watercourses and waterbodies, the impact assessment for the Project focused on evaluating:

- changes in water and sediment quality compared with pre-development conditions, existing and approved development effects, and regulatory guidelines for receiving surface waters in the Project area and the Athabasca River
- potential effects on thermal regime, dissolved oxygen and sediment quality in receiving surface waters within the Project area and the Athabasca River
- water and sediment quality in pit lakes within the Project area

BASE CASE

Jackpine Mine Expansion

Existing and approved projects are predicted to have low to negligible effects on key water quality constituents in receiving watercourses and waterbodies, including:

- acute and chronic toxicity
- labile naphthenic acids
- total dissolved solids
- tainting potential

Existing and proposed mitigation measures will ensure that acute and chronic toxicity and tainting potential will be at levels appreciably lower than the corresponding threshold values.

Under pre-development and Base Case conditions in the Muskeg River and Jackpine Creek, measured and predicted concentrations of the following constituents are higher than the corresponding aquatic life guideline values:

Jackpine Mine Expansion (cont'd)

- aluminum
- arsenic
- cadmium
- chromium
- copper
- iron
- lead
- molybdenum
- nickel
- PAH Groups 1, 2, 5 and 7
- selenium
- sulphide
- total nitrogen
- total phenolics
- total phosphorus
- zinc

In Kearl Lake, pre-development or Base Case concentrations of these constituents, except nickel and the PAH groups, also exceed guideline values. Natural humic materials and occasional high sulphide concentrations during periods of anoxia in these surface waters appear to produce episodic occurrences of chronic aquatic toxicity. However, in the Base Case, the Project will only marginally change background levels of aquatic toxicity, labile naphthenic acids and tainting potential.

Under Base Case conditions, increases are predicted in concentrations of other constituents, including:

- antimony
- barium
- beryllium
- boron
- cobalt
- manganese
- PAH Groups 3 and 6
- potassium
- sodium
- strontium
- sulphate
- total dissolved solids
- vanadium

Except for strontium, the predicted Base Case concentrations of these constituents are not higher than the aquatic health thresholds.

The effects of existing and approved projects on temperature, dissolved oxygen and sediment quality are predicted to be negligible. Polishing pond discharges

from the Muskeg River Mine and Muskeg River Mine Expansion, Jackpine Mine – Phase 1 and the Aurora North and South mines will have a negligible effect on Muskeg River temperatures. Furthermore, potential pit lake outflow is predicted to establish thermal equilibrium quickly, and prevailing climatic conditions are expected to result in little change in temperature compared with background or pre-development conditions. Polishing ponds in existing developments are an effective mitigation for the release of water from muskeg drainage and overburden dewatering. No effects have been observed on the dissolved oxygen levels and sediment quality of receiving surface waters. Therefore, changes to these constituents are predicted to be inconsequential for the Base Case.

Pierre River Mine

There are no existing or approved oil sands projects in the watersheds of the tributary streams to the Athabasca River in the Pierre River Mine local study area. However, the operational and closure diversion channel of the Horizon Project will be routed through the south corner of the Pierre River watershed and will cause negligible reduction in mean annual flow levels at the mouth of the river. Therefore, Base Case water and sediment quality predictions are the same as those under pre-development conditions. Concentrations of labile naphthenic acids, acute and chronic toxicity and tainting potential are predicted to be negligible and below applicable thresholds.

However, Base Case water and sediment quality in surface waters within the Pierre River, Asphalt Creek, Eymundson Creek, Big Creek and Redclay Creek, are generally different from those predicted for the Muskeg River watershed. For example, concentrations of total naphthenic acids and total dissolved solids under pre-development or Base Case conditions in the Pierre River Mine are predicted to be higher than the corresponding values in the Jackpine Mine Expansion area. Metal concentrations are higher in the Pierre River Mine area surface waters than in the Muskeg River watershed under Base Case conditions. Nevertheless, constituents that do not meet aquatic life guideline values are typically the same for the Pierre River Mine and Jackpine Mine Expansion areas.

Under pre-development and Base Case conditions, temperature and dissolved oxygen levels in the Pierre River, Asphalt Creek, Eymundson Creek, Big Creek and Redclay Creek are generally similar to levels in the Muskeg River and its tributaries. Metal concentrations in sediments tend to be much higher in watercourses within the Pierre River Mine area compared with those in the Muskeg River watershed. For both pre-development and Base Case conditions, PAH concentrations in sediments tend to be much higher in the Muskeg River watershed.

Athabasca River

In the Athabasca River, Base Case projects are predicted to result in only marginal increases in the concentrations of key constituents, such as:

- acute and chronic toxicity
- labile naphthenic acids

Athabasca River (cont'd)

- total dissolved solids
- tainting potential

These marginal increases in concentrations occur along short segments just downstream of water release points for the existing and approved developments.

Concentrations of many other constituents in the Athabasca River under Base Case and pre-development conditions are higher than the corresponding aquatic guideline values, mainly as a result of background watershed loading upstream of the oil sands region. The constituents with high concentrations include:

- aluminum
- arsenic
- cadmium
- chromium
- copper
- iron
- lead
- silver
- zinc
- total nitrogen
- total phenolics
- total phosphorus

The high concentrations typically occur during spring and summer. These constituents typically also have high concentrations in the watercourses within the Project area under pre-development and Base Case conditions.

Boron and molybdenum, which are typically associated with oil sands process-affected water, are predicted to have the highest increase compared with pre-development levels. However, the predicted concentrations of these constituents are appreciably low, limited to short distances, and would have an inconsequential effect on overall water quality and the aquatic health of the river.

Temperature, dissolved oxygen and sediment quality in the Athabasca River will not be affected by existing and approved developments. Negligible changes are expected as a result of:

- the existing and proposed mitigation, such as polishing ponds, wetlands and pit lakes

- the relatively small volume of water releases from Base Case developments compared to Athabasca River flow volumes

APPLICATION CASE

Conclusions of the Application Case assessment are provided for key questions formulated to address the water quality concerns of stakeholders and regulators. The potential effects of Project activities on constituent concentrations and compliance with aquatic life guidelines are assessed. Conclusions on water quality predictions for receiving watercourses and waterbodies are summarized.

Jackpine Mine Expansion

Water Quality

In surface waters within the Jackpine Mine Expansion area, the Project is predicted to have small to negligible effects on concentrations of key constituents, such as:

- labile naphthenic acids
- acute and chronic toxicity
- tainting potential
- total dissolved solids

The concentrations of these constituents under the Application Case are generally lower than the applicable aquatic life guidelines or threshold values. However, Project activities and the integrated operational and closure drainage plans are predicted to result in an increase of some constituents compared with the Base Case. The effects of these increased concentrations on fish, human and wildlife health were assessed, in the corresponding environmental health sections, as low or negligible.

Increases from Project Activities

In the Muskeg River, during operations in 2033 and in 2052, concentrations of chromium, cobalt, copper and PAH Groups 2 and 5 are predicted to increase as a result of:

- closed-circuiting of natural areas
- diversion of upstream reaches
- discharges of muskeg drainage and overburden dewatering

At closure, concentrations of aluminum, beryllium, boron, chromium, molybdenum, PAH Group 6, potassium, strontium, sulphate, total nitrogen and vanadium are predicted to increase above Base Case levels when the Jackpine north pit lake begins to discharge. In the far future, the large residence time of the pit lakes will result in a more gradual flushing of constituents than is observed in the Base Case. Consequently, median values of barium, beryllium, boron, cobalt, iron, PAH Group 6, potassium, strontium, sulphate, total nitrogen and vanadium are predicted to be higher than the corresponding concentrations under Base Case conditions.

Increases from Drainage Integration

Project effects on the water quality of Jackpine Creek are predicted to be negligible because the proposed expansion activities will not release water to Jackpine Creek. However, changes to the integrated closure drainage plan will result in increased concentrations of beryllium, boron, chromium, cobalt, molybdenum, PAH Group 1, potassium, strontium, sulphate and vanadium. Constituents that do not meet the guidelines under the Application Case also have higher concentrations than the guideline values under Base Case conditions.

Based on conservative modelling, peak concentrations of aluminum, cadmium and copper will increase in Kearl Lake in 2012. These increases result from reduced residence time resulting from integrating the mine plan with adjacent developments. This will involve diverting runoff from natural lands into Kearl Lake. In addition, beryllium, boron, cadmium, cobalt, molybdenum, PAH Group 6, potassium, strontium, sulphate, total nitrogen and vanadium are predicted to increase in 2065 as a result of changes to the integrated closure drainage plan. Of the constituents that are predicted to increase in concentration, only cadmium, molybdenum and total nitrogen are higher than the applicable aquatic life guideline values. Concentrations of these constituents are predicted to decrease from 2065 to the far future, as the loading from process-affected waters will decrease as a result of flushing porewater from tailings in the closure landscape.

Imperial's Kearl Compensation Lake will be connected to Kearl Lake and will receive runoff inflow entirely from Kearl Lake. Therefore, the predictions for Kearl Lake water quality apply to Imperial's Kearl Compensation Lake.

The Jackpine Mine Compensation Lake will be fed primarily by discharge from Kearl Lake. Therefore, the predictions for Kearl Lake water quality are similar to those for the Jackpine Mine Compensation Lake.

No Predicted Changes

The Project is predicted to have negligible effects on water quality of the lenticular patterned fen located upstream of the Project. The fen will not receive runoff from the Project, and process-affected water or seepage is not predicted to enter the fen. Project activities might result in a negligible reduction in groundwater discharge and associated solutes to the fen, but no changes are expected in substance concentrations in water within the fen.

Thermal Regime

The water that flows from muskeg drainage and overburden dewatering to polishing ponds will typically attain equilibrium and achieve temperatures similar to ambient receiving stream temperatures. Occasionally, the water temperature of some ponds might exceed receiving stream temperatures. However, the most extreme cases will increase receiving stream temperatures by less than 1°C, with negligible effects on the receiving stream.

Releases from pit lakes will be from surface layers, and as a result, will have temperatures similar to the waterbodies in the oil sands region, or will quickly attain equilibrium with background receiving stream temperatures.

Integrating the mine plan with adjacent developments will result in changes in the water balance of Kearl Lake, the Kearl Compensation Lake and the Jackpine Mine Compensation Lake. However, changes in water temperature in these lakes will be negligible.

Dissolved Oxygen

Muskeg and overburden drainage from the Project are not expected to affect dissolved oxygen levels in receiving streams. Data obtained from the operations of Albian Sands, Shell and Syncrude polishing ponds suggest that oxygen-consuming constituents will be reduced to concentrations similar to the background levels observed in the Muskeg River.

The data also confirms that dissolved oxygen concentrations in polishing pond waters are often higher than background levels for the small receiving streams, particularly during winter. Winter dissolved oxygen concentrations are not predicted to decrease under the Application Case because flow levels during the ice-cover period will not decrease compared with Base Case conditions.

Integrating the mine plan with adjacent developments will result in changes in the water balance of Kearl Lake, the Kearl Compensation Lake and the Jackpine Mine Compensation Lake. However, changes in dissolved oxygen concentration in these lakes will be negligible.

Sediment Quality

Predicted changes in PAH and metal in the sediments of receiving watercourses and waterbodies as a result of the Project are negligible. The reclamation landscape and operational and closure drainage systems will be designed to be geotechnically stable with a low potential for erosion. The limited pathways for PAHs and metals will be because of mitigation, such as polishing ponds, wetlands and pit lakes, which will trap eroded soils and particulate constituents in surface waters.

Pit Lakes

Pit lake water quality is predicted to be non-toxic before the lakes start discharging to the Muskeg River. Some constituent concentrations are predicted to be higher than aquatic life guideline values. However, key constituents, such as acute and chronic toxicity, labile naphthenic acids and tainting potential are predicted to have concentrations below aquatic threshold values or within the natural variability of existing local surface waterbodies. Constituents with higher concentrations than guideline values are molybdenum and PAH Group 2. Predicted concentrations of boron, refractory naphthenic acids, PAH Group 6, sodium, strontium, sulphate, total dissolved solids and vanadium are higher than the corresponding values for surface waters in the oil sands region. However,

Pit Lakes (cont'd)

these constituents have no guideline values and the predicted concentrations will have low to negligible effects on aquatic health.

Constituent concentrations in the pit lakes and their outflows typically decrease with time. Concentrations in the far future are predicted to reach equilibrium levels that are similar to, or approach, background levels for local and regional waterbodies. Flushing process-affected porewater from reclamation material, and the reduction in tailings flux waters with time, will result in decreased constituent loading and improved water quality within the lakes and their releases to the receiving environment.

Metal concentrations in pit lake sediments, including those with mature fine tailings, are expected to be within the range of concentrations observed in sediments from existing lakes in the oil sands region. Although PAHs in pit lake sediments might exceed levels observed in regional waterbodies, studies conducted on the sediments of reclamation waterbodies containing mature fine tailings suggest that pit lakes will develop into self-sustaining and biologically productive systems.

Pierre River Mine

Water Quality

The Project is predicted to have small to negligible effects on concentrations of key constituents, such as labile naphthenic acids, acute and chronic toxicity, tainting potential and total dissolved solids in surface waters within the Pierre River Mine Area. The concentrations of these constituents under the Application Case are generally lower than the applicable guideline or aquatic threshold values. However, Project activities are predicted to result in increased concentrations for some constituents compared with the Base Case. The effects of these increased concentrations on aquatic health are assessed as low or negligible.

The Project is predicted to have negligible effects on water quality in the Pierre River.

Project effects on Asphalt Creek water quality will be limited to slight increases in beryllium, refractory naphthenic acids and PAH Groups 1, 2 and 5. These increases will be limited to the muskeg drainage and overburden dewatering period of 2015 to 2018. The Project is predicted to have negligible effects on water quality in Asphalt Creek during the remaining time snapshots because this creek will not receive any mine-related discharge at any other time.

The diversion and impoundment of Big Creek is predicted to increase median concentrations of aluminum, antimony, chromium, cobalt, iron, manganese, potassium and vanadium. In contrast, peak values of these constituents are predicted to decrease under the Application Case. Of these constituents, aluminum, chromium and iron concentrations are predicted to be higher than

applicable aquatic life guideline values, mainly as a result of loading from natural background sources.

Big Creek water quality is assessed at Redclay Compensation Lake. Therefore, predictions and conclusions for Big Creek also apply to this waterbody.

Thermal Regime

Water that flows from muskeg drainage and overburden dewatering to polishing ponds will typically attain equilibrium and achieve temperatures similar to ambient receiving stream temperatures. Occasionally, the water temperature of some polishing ponds might exceed receiving stream temperatures. However, the most extreme cases will increase receiving stream temperatures by less than 1°C. Releases from pit lakes will be from surface layers, and as a result will have temperatures similar to waterbodies in the oil sands region, or will quickly attain equilibrium with background receiving stream temperatures.

Dissolved Oxygen

As in the Jackpine Mine Expansion, muskeg and overburden drainage from the Pierre River Mine is not expected to affect dissolved oxygen levels in receiving streams.

Sediment Quality

As in the Jackpine Mine Expansion, effects on sediment quality in receiving waterbodies in the Pierre River Mine are predicted to be low or negligible.

Pit Lakes and Treatment Lake

Water quality in the Pierre River Mine pit lakes and the treatment lake is predicted to be non-toxic before the lakes start discharging into the Athabasca River. The concentrations of some constituents are predicted to be higher than water quality guideline values, but key constituents, such as labile naphthenic acids, acute and chronic toxicity and tainting potential, are predicted to have concentrations below aquatic threshold values or within the natural variability of existing local watercourses and waterbodies. Concentrations of total dissolved solids are predicted to exceed observed natural variation in some treatment waterbodies. Constituents with higher concentrations than guideline values are iron and PAH Group 2. Predicted concentrations of barium, boron, manganese, refractory naphthenic acids, PAH Group 6, potassium, sodium, strontium, sulphate, total dissolved solids and vanadium are higher than the corresponding values for surface waters in the oil sands region. However, these constituents have no guideline values, and the predicted concentrations will have low to negligible effects on aquatic health.

Constituent concentrations in the pit lakes and the outflow from them typically decrease with time. Concentrations in the far future are predicted to reach equilibrium levels that are similar to, or approach, background levels for waterbodies in the oil sands region. Flushing process-affected porewater from reclamation material, and the reduction in tailings flux waters with time, will

Pit Lakes and Treatment Lake (cont'd)

result in decreased constituent loading and improved water quality within the lakes and their releases to the receiving environment.

As in the pit lakes in the Jackpine Mine Expansion, the Pierre River Mine pit lakes are predicted to have PAH and metal concentrations that will support self-sustaining and biologically productive aquatic systems.

Athabasca River

Water Quality

Project activities are predicted to have negligible effects on water quality in the Athabasca River. Key constituents, such as labile naphthenic acids, acute and chronic toxicity, tainting potential and total dissolved solids are predicted to increase only marginally in the Athabasca River under the Application Case. Similarly, Project activities are predicted to have negligible effects on most constituents.

However, concentrations of boron and refractory naphthenic acids in the Athabasca River are predicted to increase downstream of the Muskeg River at the end of decommissioning and in the far future. These increases are restricted to a small area of the river, and are predicted to have negligible effects on fish, wildlife and human health.

Thermal Regime

Water temperature in the Athabasca River will not be affected by the Project, because of mitigation and the relatively small volume of water releases compared to river flow volumes.

Dissolved Oxygen

Dissolved oxygen in the Athabasca River will not be affected by the Project, because of mitigation and the relatively small volume of water releases compared to river flow volumes.

Sediment Quality

Sediment quality in the Athabasca River will not be affected by the Project, because of mitigation and the negligible change in water quality in the Athabasca River compared with pre-development and Base Case conditions.

MITIGATION, MONITORING AND MANAGEMENT

Mitigation

The main mitigative measures that will be implemented to reduce the effects of the Project on water quality include:

- polishing ponds
- closed-circuit water recycling during operations
- perimeter ditches and wells
- wetlands, pit lakes and a treatment lake
- a self-sustaining closure landscape and drainage system
- best management practices

Polishing Ponds

Water that flows from muskeg drainage and overburden dewatering will be directed to polishing ponds. The ponds will be equipped with oil removal capabilities, where appropriate, and will:

- trap eroded soil material
- reduce suspended particulates, organics and oxygen-consuming constituents
- allow water to approach ambient water temperatures, before being released to the environment

Closed-Circuit Water Recycling During Operations

If released directly into receiving waterbodies, process-affected waters, runoff and seepage from areas affected by mine operations might have high concentrations of constituents that can affect water quality. These waters might include:

- cooling tower water
- non-segregated tailings flux water
- tailings and groundwater seepages
- runoff from in-pit and active mine pit areas
- tailings pond water
- surface runoff from the plant site and roads
- runoff from the mine footprint

During operations, the process-affected waters that can be captured generally will not be released into the environment, but will be recycled in the process stream.

Perimeter Ditches and Wells

Tailings pond water from the ETDAs has the potential to seep into receiving surface waters as a result of the hydraulic head between the pond and its surroundings. During operations, perimeter ditches and wells will capture seepage and runoff from the ETDA areas. This water will be pumped back into the tailings pond to prevent constituents with high concentrations from being released into receiving surface waters during mine operations. At closure, runoff will be directed to wetlands, pit lakes or the treatment lake. The wetlands, pit lakes and treatment lake will be of adequate size to ensure that outflow from the reclaimed landscape will be non-toxic before being released into the natural watercourses and waterbodies.

Wetlands, Pit Lakes and Treatment Lake

At closure, reclamation water and runoff will be directed to a system of wetlands, pit lakes and a treatment lake. The wetlands will provide natural pre-treatment before the water is released to the pit lakes or the treatment lake. The pit lakes and the treatment lake will be designed to have littoral zones to promote biological activity and enhance biodegradation. A littoral zone near the outlet will also provide an opportunity for pit lakes and the treatment lake outflows to attain temperatures similar to ambient temperatures of existing local streams.

The wetlands, pit lakes and the treatment lake will:

- have a large combined storage capacity and long residence time to provide treatment for the reclamation water
- provide flood storage and reduce erosion from the reclaimed landscape

Self-Sustaining Closure Landscape and Drainage System

The self-sustaining closure landscape and drainage system will be similar to natural systems in:

- dynamic stability
- robustness
- longevity
- self-sustaining capability

To reduce water and sediment quality effects on receiving streams, the reclamation drainage will be designed to limit channel erosion. The drainage system will direct all seepage and runoff after decommissioning to wetlands, pit lakes and the treatment lake.

The volume of reclamation water captured in the closure drainage system and directed into wetlands, pit lakes and the treatment lake will be maximized through the design of the reclamation landscape. This will reduce direct seepage into the receiving watercourses and waterbodies.

Most of the non-segregated tailings on the reclamation landscape will be placed below the level of lean oil sands, or behind low permeability material, to reduce the amount of seepage water from the tailings reaching receiving watercourses and waterbodies.

Natural in situ or engineered walls of low-permeability overburden will be maintained along the Muskeg River, if required, to reduce direct seepage into the river. The closure landscape will be designed to encourage effective drainage and flushing of constituents from reclaimed areas, to avoid salt accumulation on the reclaimed surfaces and potential deterioration of runoff water quality.

Best Management Practices

Accidental spills from pipeline ruptures or vehicle accidents and failure of retention structures will be handled using best management practices. Project activities will follow safety protocols designed to limit accidents and reduce effects if an accident occurs. A surface water and groundwater monitoring and response plan will be implemented, to determine the effects of accidental releases promptly and to initiate the required remedial action.

Monitoring

Regional Monitoring, Research and Management Initiatives

Shell is a participant in:

- RAMP, which quantifies the chemical and biological effects of oil sands operations, including annual sediment monitoring in receiving waters
- CEMA, which has several initiatives to study water quality effects in receiving streams

Shell will continue to participate in these organizations to monitor water quality in receiving watercourses and waterbodies and to confirm performance of mitigation.

Project-Specific Monitoring and Management

A preliminary monitoring plan has been developed to measure the effects of the Project and to confirm that mitigation systems are effective. The plan will be updated after the Project has been approved, to satisfy AENV and DFO requirements.

Discharge into Receiving Surface Waters

The proposed preliminary monitoring plan will provide the necessary data regarding the water quality of discharge volumes and the corresponding in-stream water and sediment quality changes. This plan was developed in conjunction with existing Albian Sands and Shell monitoring programs and other programs in the region.

Polishing Ponds

Polishing ponds will be monitored for temperature, dissolved oxygen, biochemical oxygen demand and other constituent concentrations, to confirm that mitigation is effective and to satisfy regulatory requirements. If the monitoring program indicates that the ponds are not performing as effectively as expected, and effects on receiving waters are observed or expected, the appropriate mitigation will be implemented.

Pit Lakes

Pit lake water chemistry will be monitored during the filling period before release. If the monitoring data indicates that releases will be toxic or cause undesirable effects on receiving streams, the filling rate could be reduced to allow longer time for toxic constituents to biodegrade. If required, passive treatment in the lakes might also be enhanced, or outflow directed to treatment wetlands for further treatment, to produce satisfactory water quality before release to receiving surface waters.

The temperature of outflow and downstream receiving waters will be monitored continuously for an appropriate period, to ensure that thermal effects, if any, on receiving streams are small. If detrimental changes to the thermal regimes of receiving streams are observed or expected, outflow from the pit lakes will be directed to ponds or wetlands with adequate residence time to allow thermal equilibrium with the atmosphere to be obtained before release.

AQUATIC HEALTH

Summary of Results

Activities associated with the Project are predicted to produce changes in water quality in watercourses and waterbodies within the project development area. Changes to sediment quality as a result of the Project are predicted to be negligible. Predicted parameter concentrations, in both fish tissue and water, were compared with chronic effects benchmarks and whole effluent toxicity guidelines.

For the Muskeg River, Pierre River, Big Creek, and Eymundson Creek, negligible environmental consequences on aquatic health were predicted. For Jackpine Creek and Kearl Lake, which are affected by drainage integration, negligible environmental consequences on aquatic health were also predicted.

The Project is also predicted to result in negligible changes to water quality and sediment quality in the Athabasca River. Therefore, potential effects on aquatic health in the Athabasca River were rated as negligible.

The assessments of water quality parameters, sediment quality and fish tissue quality, along with the results of field and laboratory research and the planned design of the Project's pit lakes, indicate that the pit lakes are expected to be able to support a viable aquatic ecosystem after decommissioning.

FISH AND FISH HABITAT

Scope of Assessment

The fish and fish habitat assessment addresses the potential effects of the Jackpine Mine Expansion and the Pierre River Mine (the Project) and drainage integration, in combination with other developments, on aquatic biological resources, which include:

- fish habitats
- fish populations
- benthic invertebrate communities

Scope of Assessment (cont'd)

The Project area includes the watercourses and waterbodies near the proposed development as well as downstream watercourses connected to those in the project development areas.

Summary of Results

Jackpine Mine Expansion

Fish Habitat and Fish Abundance

During Jackpine Mine Expansion area construction, operations, closure and reclamation activities, changes in habitat area will occur in the upper Muskeg River watershed, which include:

- the upper Muskeg River mainstem
- lower Wapasu Creek
- unnamed tributaries and waterbodies within the upper watershed

A portion of the habitat compensation planned for Jackpine Mine – Phase 1 (Khahago Lake) will also be lost as a result of the Jackpine Mine Expansion. However, the Conceptual Compensation Plan (CCP) will offset predicted habitat losses so that no net loss will occur in the productive capacity of fish habitats, and fish populations in the region will have no adverse residual effects.

Landscape and drainage alterations are expected to result in changes in flow in the Muskeg River downstream of the Jackpine Mine Expansion development area. Increases in winter flow in 2033 and in the far future would be expected to have a positive effect on the quality and quantity of overwintering habitat in the Muskeg River for fish key indicator resources (KIRs), because winter dissolved oxygen levels are also expected to improve. However, predicted reductions in peak flow volumes might result in a loss of fish habitat as a result of decreased floodplain inundation.

For a short period in 2052, the Jackpine Mine Expansion will likely have a negative, low magnitude impact on fish habitat, based on reduced flow levels for all flow statistics.

In the far future, the project will result in improved winter and 7Q10 flows, with all other changes in flow, compared with the Base Case, being minimal. The overall impact of changes in streamflow will be negligible. However, Shell will compensate for the loss of habitat area in the Muskeg River resulting from the decrease in flow from mine development, and will participate in regional monitoring programs in the Muskeg River. Habitat losses in Reaches 1 to 5 and the lower half of Reach 6 of the Muskeg River downstream of the Jackpine Mine Expansion Area have been considered in the Conceptual Compensation Plan.

The changes in the spring flow regime might also affect migration for the most abundant spring spawning species, such as northern pike and suckers. The potential changes to habitat accessibility, from the reduction in peak flow levels

and increased density of beaver dams, are likely negative in direction and low in magnitude, and are likely to vary depending on the fish species and life stage. However, consideration of the habitat losses in the Muskeg River for migratory species has been included in the Conceptual Compensation Plan.

Taking into account the compensation associated with the Project, residual impacts on the quality and quantity of fish habitat and on habitat accessibility resulting from changes in peak flow levels in the Muskeg River are expected to be negligible in magnitude.

During operations, Kearl Lake water levels are expected to increase during both open-water and ice-covered periods, although most of the increase results from Base Case conditions. The predicted changes to lake levels are less than 0.30 m on average, which would be expected to have negligible effects on fish habitat in Kearl Lake or in the adjacent Kearl Compensation Lake. Fish accessibility to Kearl Lake could be affected during mine operations, because after Muskeg Creek is eliminated, the Kearl Lake outflow will be conveyed through a diversion channel and then a gravity pipeline system to the Muskeg River. However, Shell has committed to maintaining natural levels of fish passage between Kearl Lake and the Muskeg River during operation of the diversion channel and pipeline system. As a result, the magnitude of the impact to fish habitat accessibility is considered to be negligible.

Taking into account the mitigation and habitat compensation associated with the Project, the residual impacts on fish habitat and fish abundance in the Jackpine Mine Expansion Area were classified as having no environmental consequence.

Fish and Fish Habitat Diversity

With the proposed habitat compensation plan, including the development of the compensation lake, the Jackpine Mine Expansion area has the potential to improve the richness and abundance of fish species, and positively affect fish species diversity. However, the change in habitat types from lotic (flowing watercourse) to lacustrine (lake) might have a low-level effect on fish habitat and benthic invertebrate diversity.

The overall impacts of the Jackpine Mine Expansion area on fish and fish habitat diversity are predicted to be negligible. As a result, no overall environmental consequence is predicted for any potential impacts on fish and fish habitat diversity in the Jackpine Mine Expansion area.

Pierre River Mine

Fish Habitat and Fish Abundance

Habitat losses in watercourse segments and waterbodies will occur in:

- the lower Pierre River
- lower Eymundson Creek
- lower Asphalt Creek
- lower Big Creek

Fish Habitat and Fish Abundance (cont'd)

- lower First Creek
- unnamed tributaries and waterbodies in the following watersheds:

    - the Pierre River
    - Eymundson Creek
    - Big Creek
    - Redclay Creek
    - the Athabasca River

However, the Conceptual Compensation Plan will offset predicted habitat losses so that no net loss occurs in the productive capacity of fish habitats, and fish populations in the region have no net adverse effects.

Operational and closure diversions in the Pierre River, and Eymundson, Asphalt, First and Big creeks will be designed to provide fish passage and maintain fish connectivity with upstream watercourses during construction and operations and at closure. As a result, impacts on fish accessibility are considered negligible for watercourses and waterbodies in the Pierre River Mine development area. Taking mitigation and habitat compensation into account, the residual impacts on fish habitat and fish abundance in the Pierre River Mine area were classified as having no environmental consequence.

Fish and Fish Habitat Diversity

With the proposed habitat compensation plan, including the development of the compensation lake, the Pierre River Mine area has the potential to improve the richness and abundance of fish species, and positively affect fish species diversity. However, the change in habitat types from lotic (flowing watercourse) to lacustrine (lake) might have a low-level effect on fish habitat and benthic invertebrate diversity. However, the overall impacts of the Pierre River Mine area on fish and fish habitat diversity are predicted to be negligible. As a result, no overall environmental consequence is predicted for any potential impacts on fish and fish habitat diversity in the Pierre River Mine area.

Athabasca River

Fish Habitat and Fish Abundance

Some small-scale effects on fish habitat in the Athabasca River will occur from installing the freshwater intake and service bridge. When detailed design for the intake and bridge is complete, regulatory requirements will be determined, including compensation if required. Taking into account mitigation and habitat compensation, no residual impacts for the Athabasca River are expected as a result of changes in habitat area. The overall effect of the reduced invertebrate drift input from losses of watercourse and waterbody habitats associated with the Project is expected to be small, with a negligible impact. The amount of drift contributed by Athabasca River tributaries is considered small compared with the amount of background drift in the Athabasca River.

Additional water withdrawals will result in reductions in flow in the Athabasca River that could affect habitat availability and fish habitat conditions. However, as Shell has committed to operate under the Water Management Framework for the lower Athabasca River, no measurable impacts on fish habitat, beyond those outlined in the framework, are expected as a result of changes to instream flow regimes resulting from the Project. Shell will also compensate for any measurable losses to fish habitat in the Athabasca River resulting from its operations, as part of the Phase 2 process of the framework. Therefore, residual impacts on fish habitat from changes in Athabasca River streamflow resulting from the Project are predicted to be negligible. Taking into account the mitigation and habitat compensation associated with the Project, the residual impacts on fish habitat and fish abundance in the Athabasca River were classified as having no environmental consequence.

Fish and Fish Habitat Diversity

No residual impacts of the Project on fish and fish habitat diversity are expected for the Athabasca River.

Mitigation, Monitoring and Management

Several mitigation measures will be implemented during the construction, operations, closure and reclamation activities for the Project to alleviate the effects on fish habitat, fish abundance and fish and fish habitat diversity. Mitigation measures include:

- designing operational diversions and closure channels to allow fish passage
- reducing effects on flow and water levels in receiving streams and lakes
- maintaining the integrity of existing riparian zone and shoreline areas
- using best practices, including sediment and erosion control during construction activities
- screening the water intake to meet federal and provincial requirements
- implementing a fish salvage program for watercourse segments and waterbodies that will be permanently lost as a result of proposed activities
- developing fish habitat of equivalent or higher productive capacity, where prevention of habitat alteration or loss is not feasible

The Conceptual Compensation Plan is designed to develop new habitat area to offset losses in habitat in the project development areas, and to achieve no net loss of the productive capacity of fish habitat. The Conceptual Compensation Plan includes developing a compensation lake in the lower Big Creek watershed (Redclay Compensation Lake), and closure channels to provide year-round habitat for species native to the regional study area. Permanent closure channels associated with the Project will be designed to provide fish habitat and fish

Mitigation, Monitoring and Management (cont'd)

accessibility, and will be included as compensation in the detailed No Net Loss Plan. The No Net Loss Plan will be developed in consultation with the appropriate regulatory agencies and stakeholder groups.

Monitoring will be conducted as part of Shell's adaptive management strategy, to verify predicted effects and to confirm that the no net loss objective has been achieved. Final details of the habitat compensation plan, monitoring requirements and adaptive management strategies will be included in the detailed No Net Loss Plan.

Shell will also implement a comprehensive monitoring program for hydrology, water quality and fish and fish habitat. This program might include assessing:

- streamflow
- water levels
- discharge rates
- channel stability and morphology
- water and sediment quality
- littoral zone development
- growth of aquatic vegetation
- benthic invertebrate communities
- fish populations
- riparian zone vegetation

In addition to project-specific monitoring activities, Shell will continue to participate in RAMP, CEMA, CONRAD and other regional initiatives and technical working groups devoted to ongoing research, development and aquatic monitoring in the oil sands region. Shell will also meet the requirements of the Athabasca River Water Management Framework.

SCOPE OF ASSESSMENT

The environmental consequences of the Jackpine Mine Expansion and the Pierre River Mine (the Project) on terrestrial resources are determined for operations, and after closure and reclamation.

SUMMARY OF RESULTS

Operations

For operations, a complete loss of soil and terrain, terrestrial vegetation, wetlands and forest resources, wildlife and biodiversity will occur in the project development area. Therefore, at the scale of the local study areas, the environmental consequence for terrestrial resources is predicted to be high for 25 to 50 years, depending on the resource.

Closure and Reclamation

After closure, this high environmental consequence will be reduced, with reclamation, to negligible or low. The Conservation and Reclamation (C&R) Plan describes how the development area will be returned to equivalent land capability, including traditional land use, wildlife habitat and forest productivity.

After reclamation, regional environmental consequences for all resources are predicted to be negligible or low. The primary impacts on terrestrial resources after closure and reclamation include:

- an increase in land capability areas that are rated conditionally productive, low and moderate for forestry land capability. This environmental consequence is negligible in the local and regional study areas.

- the permanent loss of 5,739 ha of soil and terrain landforms (11% of the local study areas), as a result of developing pit lakes and the compensation lake. This environmental consequence is high at the local study area scale and negligible in the regional study area.

- an increase, within the local study areas, of five vegetation key indicator resources, including:

    - forested areas
    - terrestrial vegetation

Closure and Reclamation (cont'd)

  - lichen jack pine communities
  - riparian communities
  - economic forests

- in the local study areas, high environmental consequences for wetlands (including peatlands and patterned fens), and rare plants, rare and special plant communities and areas of high rare plant potential, as follows:

  - 15,021 ha of wetlands, including 13,819 ha (81%) of peatlands will be cleared as a result of the Project

  - almost 85% of the 469 rare plant occurrences documented in the local study areas will be removed

  - areas of high rare plant potential will be reduced by 8,956 ha (56%), primarily as a result of the loss of peatlands

  - old growth forests will be reduced by 1,223 ha (40%) in the local study areas. Although old growth forests will develop in the reclaimed landscape, forest stands will not be old enough to be classified as old growth within the time frame used for closure in the assessment (80 years). However, a low environmental consequence is predicted for old growth forests.

- an increase in the area covered by water, e.g., lakes, in the closure landscape

- an increase in available habitat for seven of the nine wildlife key indicator resources, including:

  - moose
  - Canada lynx
  - fisher and marten
  - black bear
  - beaver
  - black-throated green warbler
  - Canadian toad

Barred Owl Habitat

Because the reclamation landscape has the potential to develop barred owl habitat, i.e., old growth forest, beyond the time frame of this assessment, a low environmental consequence was assigned to the loss of barred owl habitat at the local study area scale. The environmental consequence of the loss of barred owl habitat is predicted to be negligible in the regional study area.

Yellow Rail Habitat

The Project will result in a high magnitude loss of yellow rail habitat, resulting in a high environmental consequence for yellow rails in the local study areas. About

5,987 ha (11.8% of the local study areas) of yellow rail habitat exists, primarily in the Jackpine Mine Expansion local study area, and an estimated 4,938 ha (9.7% of the local study area) will not be reclaimed. Yellow rails have been recorded only sporadically despite landscape-scale surveys throughout the region. The population is likely distributed sporadically across suitable habitat and in low numbers. Therefore, the loss of yellow rail habitat as a result of the Project is unlikely to affect the viability of the yellow rail population at the scale of the regional study area, resulting in a negligible environmental consequence at that scale.

Wildlife Movement

Before closure, the effect of the Project on wildlife movement in the Jackpine Mine Expansion local study area is predicted to have a high environmental consequence in the Application Case at the local study area scale. However, a negligible to low environmental consequence is predicted for wildlife at the scale of the local and regional study areas after reclamation.

The Project is predicted to have a low environmental consequence on wildlife movement in the Pierre River Mine local study area after mitigation. A negligible to low environmental consequence is predicted for wildlife at the scale of the local and regional study areas after closure and reclamation.

Land Capability

After reclamation, an increase will occur in land capability areas rated conditionally productive, low and moderate for land capability for forestry. This was rated as having a negligible environmental consequence in the local and regional study areas.

Biodiversity

The changes in biodiversity at the three levels of biological organization, i.e., species, ecosystem and landscape levels, are predicted to be negative and of high environmental consequence in the local study areas and low in the regional study area.

APPLICATION CASE

The effects of the Project on terrestrial resources in the local study areas are assessed for the Application Case. Incremental effects of the Project over the Base Case are assessed. Soil and terrain, terrestrial vegetation, wetlands and forest resources, wildlife and biodiversity are assessed.

The analysis of potential linkages indicates that losses or alteration of terrestrial resources primarily result from site clearing and open pit mining. A maximum development area of 32,495 ha (64% of the local study areas), which includes previously approved disturbance areas for Jackpine Mine – Phase 1 (7,785 ha), was assessed for terrestrial resources within the local study area. However, the total area to be cleared as a result of the Project and Jackpine Mine – Phase 1 is

APPLICATION CASE (cont'd)

31,274 ha, because 1,221 ha of additional Base Case disturbance exist outside the proposed project development area.

At the scale of the local study areas, the assessment of the Project after closure and reclamation indicated that 13 of the 25 components will experience a net negligible or positive change. High-quality habitat for seven of nine wildlife KIRs is predicted to increase after closure and reclamation as a result of increased terrestrial habitat in the reclaimed landscape. The other linkages that result in low to high adverse environmental consequences within the local study areas include:

- permanent loss of soil as a result of an increase in waterbodies, i.e., pit lakes
- loss of wetlands
- loss of old growth forests
- loss of special plant communities and areas with high rare plant potential
- reduced wildlife abundance for migratory bird KIRs
- reduced wildlife movement for most terrestrial wildlife KIRs
- changed biodiversity as a result of changes in abundance, distribution and composition at the species, ecosystem and landscape levels of biological organization

Residual effects of the Project on terrestrial resources in the regional study area are predicted to be negligible or low.

Soil and Terrain

A total of 50,640 ha of soil and terrain units are mapped for the local study areas for the Base Case. The Project will result in a development area of 32,495 ha (64% of the local study area), which will affect soil and terrain units under the Application Case.

Soils will be disturbed, i.e., removed and suitable material used for reclamation, during construction, operations and reclamation. In the local study areas, 30,828 ha of soils will be affected, including 10,755 ha of mineral soils, 13,855 ha of organic soils and 6,218 ha of reclaimed soils from the Jackpine Mine – Phase 1 area. Developing the pit lakes will result in a permanent reduction of 5,623 ha in the area of soils.

Soil disturbance and removal will be mitigated by reconstructing reclaimed soils in 25,444 ha (50%) of the local study areas. The reclaimed soils will generally be mineral soils, including reclaimed areas of peat–mineral mixture and areas using native mineral soil horizons. The reclaimed soils and terrain are predicted to

result in a shift to a drier landscape at closure, which will provide a higher average land capability for forestry compared with Base Case conditions.

Terrestrial Vegetation, Wetlands and Forest Resources

The Project will result in an increase of 10,231 ha (20%) of terrestrial vegetation in the local study areas following reclamation. About 15,021 ha (29%) of wetlands will be replaced by upland vegetation or pit lakes, which represents a high environmental consequence within the local study areas. Wetland areas that are not reclaimed to upland terrestrial vegetation or riparian vegetation will become waterbodies.

The following changes will occur in specific ecosite phases and wetland types as a result of the Project:

- old growth forests will decrease by 1,223 ha, resulting in a low environmental consequence in the local study areas and negligible consequence in the regional study area
- wetlands, including peatlands will decrease by 29%, and patterned fens will decrease by 586 ha. These changes will result in a high environmental consequence in the local study areas and negligible consequence in the regional study area.
- the rare plant occurrences observed in the local study area will decrease by 85%. The lenticular patterned fen, one of the three special plant communities within the local study areas, will be affected, resulting in a high environmental consequence. About 8,956 ha (17%) of high rare plant potential will be lost in the local study areas as a result of the Project. These effects result in a high environmental consequence in the local study areas and negligible consequence in the regional study area.
- surficial aquifer drawdown was conservatively predicted to affect 1,883 ha of fens within and outside of the local study areas. This loss affects 4% of the local study areas, resulting in a low environmental consequence in the local study areas and negligible consequence in the regional study area.

The following KIRs will either have a change that is positive in direction, or no change as a result of the Project:

- forested areas will increase by 2,164 ha (7%), resulting in a negligible, positive environmental consequence
- non-forested areas will decrease by 944 ha (6%), resulting in a negligible, negative environmental consequence
- natural areas will increase by 1,219 ha (3%), resulting in a negligible, positive environmental consequence

Terrestrial Vegetation, Wetlands and Forest Resources (cont'd)

- lichen jack pine communities will increase by 173 ha (less than 1%) and riparian communities by 3,335 ha (7%), resulting in a negligible, positive environmental consequence

- areas of economic forest stands are predicted to increase after closure by 7,569 ha, or 15% of the local study areas

Wildlife

Abundance

Residual impacts from project activities that result in wildlife interacting with project infrastructure, are predicted to have a negligible environmental consequence rating for two KIRs and a low rating for the remaining seven.

Activities that result in direct mortality include site clearing, removing nuisance wildlife and highway mortality. Residual impacts from these activities are predicted to have a negligible to low environmental consequence for all KIRs.

Residual effects as a result of stress from sensory disturbance are difficult to predict. However, most KIRs affected by sensory disturbance are expected to habituate to the disturbance effects of the Project to some extent. Therefore, the magnitude for all KIRs was predicted to be negligible to low.

Overall, the predicted environmental consequence for wildlife abundance varies from negligible to low, and is considered negligible for all linkages at the regional study area scale.

Direct and Indirect Habitat Loss

Direct and indirect habitat losses are high in magnitude for all KIRs before reclamation within the local study areas. They range from a loss of 51% (high-quality lynx habitat) to 86% (high-quality yellow rail habitat). On average, two-thirds of the habitat that is rated moderate or better in the local study areas for each KIR is predicted to be lost during operations.

At closure, the landscape will shift from wetland habitats to terrestrial habitats, and within the 80-year assessment time frame, will shift from early successional habitats to mid-successional habitats. Habitat gains for black-throated green warbler as a result of terrestrial uplands being established are predicted to be as high as 382% over Base Case conditions. Predicted increases in high-quality habitat after reclamation are:

- 80% for moose
- 18% for Canada lynx
- 36% for fisher and marten
- 6% for black bear
- 34% for Canadian toad

Habitat suitability modelling indicates that barred owls and yellow rails are predicted to experience high long-term negative environmental consequences as a result of habitat loss in the local study area. Barred owls appear to prefer mixedwood forests over 80 years of age in Alberta's boreal forest. However, old growth mixedwood forest stands have the potential to develop in the reclaimed landscape over 100 years or more after the 80 year timeframe used for this assessment. Consequently, habitat loss for the barred owl is assigned a low environmental consequence at the local study area scale, and a negligible environmental consequence at the regional study area scale.

Based on the Habitat Suitability Index (HSI) modelling, yellow rail habitat, i.e., graminoid and shrubby fens and graminoid marshes, is not predicted to reach Base Case levels in the closure landscape. Although Sh3 shrublands might be considered suitable habitat for yellow rails in the closure landscape, even if Sh3 shrublands are included, the loss of yellow rail habitat remains a high magnitude loss. Therefore, this results in a high environmental consequence for yellow rails at the local study area scale. Yellow rails have been recorded only sporadically despite landscape-scale surveys throughout the region. The population is likely distributed sporadically across suitable habitat and in low numbers. In addition, potential yellow rail habitat is well distributed throughout the regional study area. Therefore, the loss of yellow rail habitat as a result of the Project is unlikely to affect the viability of the regional yellow rail population.

Wildlife Movement

Two wildlife movement corridors, the Muskeg River and the Athabasca River, are assessed for this project. The Muskeg River is located within the Jackpine Mine Expansion local study area. Regional developments along the Muskeg River, including the Jackpine Mine Expansion local study area, will create a 20-km-long remnant corridor about 400 m wide along the Muskeg River from the Athabasca River to the Fort Hills. The effect of the Project on wildlife movement in the Jackpine Mine Expansion local study area is predicted to have a high environmental consequence before closure, and a negligible to low environmental consequence after closure and reclamation.

The Athabasca River flows along the east side of the Pierre River Mine local study area. The Pierre River Mine development plan has been designed to maintain a buffer of at least 250 m from the Athabasca River. This buffer will maintain the 250 m movement corridor that was committed to by Canadian Natural for the Horizon Project.

The proposed bridge spanning the Athabasca River, and the mining activity in the Pierre River Mine area, will create filters or barriers to movement along the west bank of the Athabasca River. However, the bridge was designed to allow wildlife to pass beneath it during operations, by maintaining an underpass above the high water mark. The Project will also create a barrier to movement within the regional study area. Wide-ranging animals, such as ungulates and large and small carnivores, will be most affected.

Wildlife Movement (cont'd)

After mitigation, the Project is predicted to have a low environmental consequence on wildlife movement in the Pierre River Mine local study area and a negligible to low environmental consequence in the regional study area. Similarly, after closure and reclamation, the Project will have a negligible to low environmental consequence.

The Jackpine Mine – Phase 1 Wildlife Corridor Monitoring Program was designed to collect information on wildlife composition, abundance and distribution throughout the year along two reaches of the Muskeg River, in the Jackpine Mine Expansion local study area both upstream of, and adjacent to, the Muskeg River Mine. The three study areas have differing levels of development and different physical characteristics, e.g., corridor width and valley type. Therefore, results from this monitoring provide insights into the potential effects of the Project on wildlife use and movement.

This monitoring demonstrated that many species use the riparian areas and upland areas adjacent to rivers, such as the Athabasca River, Muskeg River and Jackpine Creek. Wary, wide-ranging species, including wolves, black bears, fishers and martens, were recorded within the corridors adjacent to developments at least once during the year. These preliminary monitoring results show that most wildlife species have been documented using habitat within the existing corridors along the Muskeg and Athabasca rivers. This suggests that genetic connectivity for most species of wildlife will be maintained within the regional landscape. That is, at least one to 10 effective migrants per generation of all wildlife species will pass through these wildlife corridors. Maintaining genetic connectivity will limit the loss of genetic diversity within the region.

A quantitative assessment of the Application Case and the Planned Development Case on wildlife movement corridors was completed for moose using a linkage zone analysis (see EIA Appendix 5-4). The linkage zone analysis is used to identify areas where moose movement will be impeded, e.g., within fracture zones. Linkage zone models modify habitat suitability scores using information about habitat quality, patch size and anthropogenic features to identify areas where movement will be impeded. Moose habitat in the regional study area is 21% fractured in the Base Case. Results from the linkage zone analysis for moose indicate that incremental low-magnitude effects will occur on potential north–south and east–west movement corridors as a result of the Project. Future regional landscape disturbances in the Planned Development Case increase fractured habitat by 3.2% compared with the Base Case. Although the incremental impact of the Project is relatively small, almost 25% of the regional study area is fractured in the Planned Development Case.

As the model assumes that anthropogenic features and their zones of influence will be completely avoided by moose, the modelled percentage of fractured habitat is likely higher than actual and, therefore, conservative in nature. In addition, this assessment considers all projects to be in a developed state and does not account for reclamation. Movement in the wildlife corridors between developments and the Athabasca River is predicted to be maintained within the

regional landscape, to a degree. This again emphasizes that the linkage zone analysis is a conservative assessment of the effects of development on wildlife movement in the regional study area. The environmental consequence of the Project on wildlife movement is predicted to be negligible to low for all KIRs at the regional study area scale after closure and reclamation.

Biodiversity

At the species level of biodiversity, the impacts of the Project on fish and fish habitat are predicted to be negative, with environmental consequences ranging from negligible to moderate in the local study areas and negligible in the regional study area. Moderate impacts at the local study area scale are primarily as a result of potential effects on fish habitat and benthic invertebrate diversity.

Impacts of the Project on terrestrial and wetland vegetation are predicted to be negative, with environmental consequences ranging from negligible to high in the local study area. High negative impacts relate primarily to the loss of peatlands, including bogs and fens, in the Jackpine Mine Expansion local study area (see EIA Volume 5, Section 7.5). All environmental consequences are negligible in the regional study area. Impacts of the Project on wildlife abundance and movement are predicted to be negative and of negligible (beaver) or low (moose, black bear, Canada lynx and fisher) environmental consequence in the local and regional study areas after closure and reclamation. Low environmental consequences in the region are expected to relate to reduced movement of moose, black bear, Canada lynx and fisher after closure (see EIA Volume 5, Section 7.5).

At the ecosystem level in the local study areas, the following changes will occur as a result of the Project:

- a 7,597 ha decrease in the area of high biodiversity potential
- a 616 ha increase in the area of moderate biodiversity potential
- a 6,981 ha increase in the area of low biodiversity potential

The net loss in the area of high biodiversity is attributed to the permanent loss of peatland wetland types, which currently cannot be reclaimed. Other high biodiversity wetland types, such as marshes and shrubby swamps, are also considered to be lost as they are not mapped in the closure landscape. The increase in the area of low biodiversity is mainly the result of an increase in abundance of some low biodiversity terrestrial vegetation types in the closure landscape.

In the regional study area, the following changes will occur as a result of the Project:

- a 9,839 ha decrease in the area of high biodiversity potential
- a 725 ha increase in the area of moderate biodiversity potential
- a 9,115 ha increase in the area of low biodiversity potential

Biodiversity (cont'd)

The net loss in the area of high biodiversity is attributed to the permanent loss of peatland wetland types. The increase in the area of low biodiversity is primarily the result of the increase in coniferous jack pine–black spruce in the closure landscape. The values for each biodiversity category are different between the regional and local study areas because of the difference in vegetation classification between the two scales. However, the impact assessment at each scale illustrates the relative change in biodiversity potential as a result of the Project. Overall, changes in vegetation types are predicted to result in high negative changes to biodiversity potential in the local study areas and negligible negative changes to biodiversity potential in the regional study area.

At the landscape level of biodiversity, an overall decrease in habitat fragmentation and the associated edge effects will occur after closure, because disturbances, including existing linear disturbances, will be reclaimed. The net loss of organic soils will result in changes in soil function, which will influence the establishment of wetland and peatland vegetation communities in the reclaimed landscape. Landscape heterogeneity will be reduced as a result of the:

- loss of peatlands
- increase in terrestrial vegetation types
- addition of shrublands and pit lakes to the closure landscape

Changes at the landscape level are connected to changes at the ecosystem and species level, and can alter biodiversity within the Project. At the landscape level, changes in the overall composition, distribution and abundance of vegetation types and classes contribute to the high, negative effect on biodiversity in the local study areas. However, the regional effects after closure are predicted to be negligible.

The changes in biodiversity at the three levels of biological organization result in a residual impact of the Project that is predicted to be a high environmental consequence in the local study areas and a negligible environmental consequence in the regional study area.

MITIGATION, MONITORING AND MANAGEMENT

Many of the available mitigation options are common to all terrestrial components. For example, by reclaiming an area, the soil will be replaced, which allows vegetation communities to become established along with associated wildlife habitat.

Construction

Specific mitigation measures that will reduce project effects on terrestrial resources, wetlands and biodiversity during construction include:

- limiting clearing between April 1 and August 30, to avoid the main bird breeding and ungulate calving seasons

- constructing straight roads with long sightlines, where feasible
- leaving remnant forested areas undisturbed, where practical
- providing construction staff with environmental awareness training as part of their on-site orientation
- contacting Alberta Sustainable Resource Development (ASRD), Fish and Wildlife, to assist in removing hibernating black bears if they are accidentally disturbed
- implementing regulatory standard soil handling, management and storage practices

Operations

Specific mitigation measures designed to reduce the effects of the Project during operations include:

- maintaining a 250 m wildlife corridor along the Athabasca River from the wetted edge in the 100-year-flood event
- providing for wildlife passage under the Athabasca River bridge on both the east and west banks of the river
- fencing the approaches to the Athabasca River bridge
- designing lighting to reduce light pollution in the adjacent wildlife corridor
- retaining treed buffers around or near watercourses
- planning and sharing access with other industrial partners
- storing all food waste in bear-proof containers, then transporting the containers off-site
- providing project staff with environmental awareness training as part of their on-site orientation
- posting wildlife crossing signs where key wildlife crossing areas are identified
- reducing traffic volumes by continuing to transport staff to site by bus
- enforcing traffic speed limits
- undertaking dust control on roads
- deploying and maintaining bird deterrent systems

Operations (cont'd)

- using markers, such as aviation spheres, to mark transmission lines, particularly those located above the treeline or in clearings
- expanding and implementing the existing weed control system for the Project areas

Reclamation

The key mitigation method for reducing residual effects on terrestrial resources, wetlands and biodiversity is reclamation. For the Project's C&R Plan, which is an extension and enhancement of the existing Jackpine Mine – Phase 1 C&R Plan, see EIA Volume 5, Appendix 5-2. The basic end land use goals that form the foundation of the C&R Plan include:

- reclaiming the landscape to an equivalent capability, optimizing the value of the watershed, forest productivity, fish and wildlife habitat or traditional use, in consultation with key stakeholders
- designing reclaimed landforms to include diversity and micro-topographic relief
- reclaiming and revegetating progressively
- revegetating according to the reclamation guidelines prepared by CEMA's Reclamation Working Group, including:
  - ensuring that structures are geotechnically stable
  - controlling the discharge of earth materials, by using surface erosion processes, to rates that are acceptable to the environment
  - managing the discharge of surface and seepage waters, to ensure an acceptable level of impact on watercourses
  - ensuring that the ecosystems re-established on disturbed lands will be self-sustaining and will mature naturally without presenting substantial risk to plants, or resident and migratory wildlife species

Final reclamation design will be completed in consultation with ASRD, forestry rights holders and local stakeholders.

Shell will monitor the Project by expanding its existing, AENV approved, Jackpine Mine – Phase 1 monitoring programs (see EIA Volume 5, Appendix 5-6). Shell will also design a wetland monitoring program for areas adjacent to the Project, to determine the effects of surficial aquifer drawdown. The lenticular patterned fen southeast of McClelland Lake is proposed to be included in the wetland monitoring program.

Shell will continue to actively participate in the CEMA working groups and be involved in research programs, such as the Canadian Oil Sands Network for Research and Development (CONRAD).

SCOPE

The human environment portion of the EIA for the Project provides the assessments and conclusions for the following components:

- Traditional Knowledge and Land Use (see EIA Volume 5, Section 8.3)
- Resource Use (see EIA Volume 5, Section 8.4)
- Visual Aesthetics (see EIA Volume 5 Section 8.5)
- Historical Resources (see EIA Volume 5, Section 8.6)
- Socio-Economics (see EIA Volume 5, Section 8.7)

TRADITIONAL KNOWLEDGE AND LAND USE

Scope of Assessment

Quantitatively, the effects of the Base Case disturbances were considered in relation to the local registered fur management areas (RFMAs) and the regional study areas (see Table 17-4). The local effects of the Project on traditional land use were evaluated in the local study areas based on the boundaries of six RFMAs that will be directly affected by the Project.

The effects of the Project in combination with existing, approved and planned regional developments were assessed in relation to the RFMAs and the regional study areas and the traditional ways of life practised by Aboriginal stakeholders, including the:

- Fort McKay First Nation (FMFN)
- Athabasca Chipewyan First Nation (ACFN)
- Mikisew Cree First Nation (MCFN)

The regional study areas were based upon the traditional territories of the Athabasca Chipewyan First Nation, Mikisew Cree First Nation and the culturally significant ecosystem (CSE) (all traditional uses) for the Fort McKay First Nation. A qualitative analysis of the effects on traditional land use within the regional and local study areas was completed based on:

- historical information provided by regional traditional land users
- specific information from holders of RFMAs in the local study area

Scope of Assessment (cont'd)

In addition, a quantitative analysis was completed to determine the total area of land that will be permanently or temporarily unavailable for traditional land use, and the amount of land that will be available for traditional land use after reclamation.

Summary of Results

The Project will negatively affect land available for hunting, trapping and plant harvesting for the six registered trappers. Two trapper cabins will be relocated in the Jackpine Mine Expansion local study area. Quantitatively, the Project will increase the area of disturbance within the RFMAs by the following amounts (see Table 17-4):

- No. 1275 (11%)
- No. 1714 (27%)
- No. 1716 (14%)
- No. 2137 (3%)
- No. 2331 (less than 1%)
- No. 2939 (2%)

On a regional scale, the Project will increase the area of disturbance within the Athabasca Chipewyan First Nation and Mikisew Cree First Nation regional study areas by less than 1% each. Within all traditional use culturally significant ecosystems for Fort McKay First Nation, the Project will increase the area of disturbance by 2% for moderate use areas, and by less than 1% for the low use and intense use areas.

Through reclamation, habitats that can support traditional plant harvesting, hunting or trapping of species, such as moose, fisher, lynx, beaver and muskrat, will be replaced in the far future.

Activities associated with Project construction and operations will result in a direct loss of land available for trapping, hunting and plant harvesting within each of the RFMAs. Trappers perceive that activities related to current industrial activities have resulted in the loss of wildlife habitat, and that noise and air emissions have negatively affected wildlife abundance.

Project activities are not expected to have a direct effect on traditional fishing, grave sites, and important ceremonial or cultural sites. Two cabins situated within the project development areas will need to be re-located. The Project will affect two berry harvesting areas situated within the project development areas (i.e., the Jackpine Mine Expansion local study area). None of the trappers harvest medicinal plants within the Pierre River Mine and Jackpine Mine Expansion local study areas. Trappers were concerned that noise, air, and light emissions would detract from their enjoyment of the traplines. Although reclamation should restore habitat with wildlife and traditional plant potential, this will not occur until the far future.

Table 17-4: Lands Affected by Base and Application Case Disturbances

	Area of RFMA (ha)	Base Case Total Disturbance Area		Application Case Total Disturbance Area		Change as a Result of the Project	
		ha	% [1]	ha	% [1]	ha	%
Registered Fur Management Area							
1275	55,403	351	1	6,207	11	5,856	11
1714	39,096	18,010	46	28,373	73	10,364	27
1716	23,657	6,872	29	10,217	43	3,345	14
2137	27,097	10,599	39	11,289	44	690	3
2331	31,389	1,106	4	1,132	4	26	<1
2939	9,216	63	1	217	2	154	2
Regional Study Area							
ACFN	4,373,928	449,998	10	482,492	11	32,494	<1
MCFN	8,634,755	587,115	7	619,609	7	32,494	<1
Fort McKay First Nation CSE for All Traditional Uses							
Low use	2,137,856	127,938	6	127,999	6	61	<1
Moderate use	861,563	156,746	18	177,543	21	20,797	2
Intense use	309,215	86,038	28	86,486	28	448	<1
Total	**3,308,634**	**370,722**	**11**	**392,028**	**12**	**21,306**	**1**

Note: Totals might appear incorrect because of rounding.

1. The percentage indicated is the contribution of the area of the disturbance to the registered fur management area, regional study area, or culturally significant area, and is rounded to the nearest whole percent.

Key issues identified by trappers include:

- a decline in wildlife numbers for hunting and trapping, which trappers associate with:
  - a loss of habitat as a result of development, noise and odours
  - increased hunting pressure because of increased access to the area
- a reduction in fish health and size as a result of industrial developments in the area
- a loss of enjoyment of their traplines because of:
  - industrial noise and odours
  - increased vandalism as a result of increased access into the area
- the concern that development makes it hard to pass on trapping skills to future generations

The EIA contains the following assessments, which are relevant to these key issues:

Summary of Results (cont'd)

- potential effects of the Project on wildlife (see Terrestrial Resources Assessment in EIA Volume 5, Section 7)
- potential effects of the Project on fish health and on fish and fish habitat (see the Aquatics Resources Assessment in Volume 4, Sections 6.6 and 6.7)
- potential effects of the Project on noise within the local study area (see the Air, Noise and Environmental Health Assessment in EIA Volume 3, Section 4)
- potential effects of the Project on air emissions (see the Air, Noise and Environmental Health Assessment in EIA Volume 3, Section 3)

Mitigation, Monitoring and Management

Compensation for Directly Affected Trapline Holders

According to industry standards, Shell will provide compensation to trappers directly affected by the Project.

Continued Consultation with Key Aboriginal Groups

Shell will continue to consult with all Aboriginal stakeholders, including Fort McKay First Nation, Athabasca Chipewyan First Nation and Mikisew Cree First Nation.

Access to Traplines

Shell will facilitate trappers' access to their traplines across the Project areas.

Employee and Contractor Education

Shell is committed to providing a system for cultural diversity awareness training for its employees and contractors to foster respect for traditional resource users, traplines, cabins, trails and equipment.

Reclamation

Traditional land use is an important end land use of the reclaimed areas. Shell's approach to reclamation involves direct consultation with First Nations and Métis groups. Shell will continue to participate in the End Land Use and Conservation and Reclamation Agreement with the Fort McKay First Nation and Fort McKay Métis Association (FMMA). This agreement involves Fort McKay residents in relevant aspects of the closure planning, implementation and research for the Muskeg River Mine.

Shell will continue to actively participate in regional multi-stakeholder planning and research initiatives that consider the long-term sustainability of effective traditional land use, including:

- CEMA
- RWG
- SEWG

Research activities for furthering the understanding of reclamation practices are completed as part of RWG or through the CONRAD.

RESOURCE USE

Scope of Assessment

The Base Case describes current conditions for resource use to provide a reference point for comparison with the Application Case and Planned Development Case.

The effects of the Project were assessed on environmentally important areas, such as environmentally significant areas, mineral and aggregate resources, agriculture, forestry, berry picking, hunting, trapping, fishing and recreation.

Summary of Results

The Project will result in a high local impact to the Eymundson Sinkholes environmentally significant area. The Eymundson Sinkholes have been designated as an environmentally significant area because of the karst topography. Baseline fieldwork for the Project indicates that the vegetation and wildlife habitat in this environmentally significant area is relatively common in the region. In addition, 46 sinkholes were identified in a 4 x 4 township area (Townships 7 to 10 and Ranges 98 to 101 W4M) near the Project. This indicates that this karst topography is relatively common in the regional study area. Therefore, removing the Eymundson Sinkholes is expected to result in an overall low impact to sinkholes in the region.

Negligible residual impacts are predicted for all remaining environmentally significant areas potentially affected by the Project, including Muskeg River (North), Athabasca River – Tar Sands Reach, Kearl Lake Moose Area, Pierre River and the Fort Hills environmentally significant areas.

Increased numbers of people associated with the Project during construction and operations have the potential to result in a low impact because of increased disturbance to environmentally significant areas and protected areas in the regional study area.

Low impacts on forestry are predicted during project operations from site clearing. Increased population pressure might also result in low impacts on hunting, fishing, berry picking and recreation throughout the regional study area because of increased competition for resources. The Project's use of aggregate material is predicted to result in a reduction of aggregate resources available in the region, and is classified as a low impact. Positive effects after closure have been predicted for forestry, berry picking and hunting as a result of reclamation.

Mitigation, Monitoring and Management

Shell will mitigate the effects of the Project on resource use by:

- ensuring that the remnant corridor between the Athabasca River and the Pierre River Mine area is at least 250 m wide, and providing a 100 m setback on other watercourses
- managing access to the development area
- working with Al-Pac to coordinate timber salvage activities, and providing compensation as necessary
- mitigating impacts on fish and wildlife, as they affect fishing, hunting and trapping, as described in the Fish and Fish Habitat and Wildlife assessments, including off-site compensation
- incorporating resource use values, such as recreational, fishing, hunting, trapping and berry picking capabilities, in reclamation plans

Monitoring of resource use is not required or planned. However, Shell will report to ASRD if discoveries of new aggregate resources or changes in estimated aggregate requirements occur.

VISUAL AESTHETICS

Scope of Assessment

The Base Case describes current conditions for visual aesthetics, to provide a reference point for comparison with the Application Case and Planned Development Case.

Nine key viewpoints were used to assess potential aesthetic effects on nine landscape units scheduled to be altered to varying degrees by the Project. The effects of facilities, infrastructure, visible plumes and mine landforms were considered for each viewpoint and modelled with Visual Nature Studio 2 landscape modelling software. When necessary, several different years were used from the same viewpoint to determine changes in effects over time.

Summary of Results

The environmental consequences of the Project on visual aesthetics are determined during operations and at closure. During the 40 to 45 years of operations, environmental consequences range from negligible to moderate. The viewpoints most affected by the Project during operations are the:

- Athabasca River, where viewpoints will be affected by the water intake facility, bridge, Pierre River Mine plant site and visible plumes

- Muskeg River, where viewpoints will be affected by the Jackpine Mine Expansion Area mine landforms

- Kearl Lake, where the Jackpine Mine Area east overburden dump area can be observed

At closure, impacts on visual aesthetics will be mitigated as the project development area will be reclaimed and facilities, such as the plant sites, water intake facility and bridge, will be decommissioned and removed. The magnitude of visual aesthetics impacts as a result of the Project will be reduced to negligible. Therefore, the environmental consequence of the Project on all landscape units will be negligible.

Mitigation

Treed Buffers

Treed buffers will be retained between road routes and the Project, wherever possible, especially along the Athabasca River.

Water Intake Location and Design

The water intake will be situated so that viewers looking downstream will have an oblique and partially obstructed view. The building materials will be low glare and painted in earth tones to reduce the contrast with the surrounding landscape. Areas cleared for construction of the water intake will be reclaimed, and vegetation will be established around the structure. This will also mitigate visual impacts.

Reclamation and Decommissioning Practices

Project areas will be reclaimed with native vegetation as soon as practical. Landforms, such as the ETDA and overburden disposal areas, will be reclaimed to blend in with their natural surroundings. For example, mine landforms will be recontoured to break up long, straight visible features.

Plant facilities, the bridge and the water intake will be decommissioned and removed from the site at the end of their operational life.

Reducing Light Pollution

Lights are necessary for the efficient, safe and secure operation of the Project. However, any light pollution, i.e., light directed above the horizontal plane that creates a sky-glow effect, associated with the plant site and areas adjacent to the Muskeg River will be reduced by:

- directing new lights downward and into the development area
- using shielded light fixtures

HISTORICAL RESOURCES

PURPOSE

The assessment of the Project's effects on historical resources during construction and operations was made by Alberta Tourism, Parks, Recreation and Culture (ATPRC) during its review of the Historical Resources Impact Assessment (HRIA). The objectives of the HRIA were to:

- identify and inventory historical resources within the Project areas
- evaluate the significance of the potential impacts on the sites
- interpret the results of the study within the framework of regional prehistory
- recommend effective management and mitigation of potential impacts

The level of investigation completed during the HRIA is considered adequate to identify any substantial historical resource concerns within the areas investigated in the proposed 10-year development area. A total of 8,069 shovel tests were excavated during these investigations.

The probability that additional unidentified archaeological sites are present, except possibly for isolated artifacts, in both the traversed and non-traversed 10-year development areas, is considered to be low. However, further Alberta *Historical Resources Act* clearance is required within the post 10-year study area.

SUMMARY OF RESULTS

Twelve previously unknown historical resource sites were identified during the HRIA for the Project (see EIA Volume 5, Section 8.6). Based on the results of the HRIA, additional subsurface testing or staged mitigation is recommended for two of the new sites, whereas 10 sites require no further work. All of the sites are believed to represent pre-contact use of the area. No historical sites were identified during the surveys. As currently proposed, project development might eventually affect all of the identified sites.

Assuming that appropriate and effective mitigation strategies will be established by ATPRC and followed by Shell, negligible direct effects on historical resources have been predicted for the Project. Indirect negative effects resulting from increased access as a result of the Project are predicted to be negligible to low.

MITIGATION

Mitigation in the form of staged information programs has been recommended for two newly recorded sites:

- one within the post 10-year Jackpine Mine Expansion area footprint
- one within the 10-year Pierre River Mine ETDA

Mitigation could include additional shovel testing and 6 to 10 m^2 of excavation per site, depending on ATPRC's recommendations. The remaining 10 sites have either been affected by previous development and are considered of low potential, or are included in the post 10-year plan for the Project.

APPLICATION FOR APPROVAL OF THE PIERRE RIVER MINE PROJECT VOLUME 2: PROJECT DESCRIPTION

INTRODUCTION

PURPOSE

This section summarizes the Socio-Economic Impact Assessment (SEIA) for the Jackpine Mine Expansion and the Pierre River Mine (referred to in the EIA as the Project).

The purpose of the SEIA is to present the Project's impacts on the socio-economic environment in the communities of the Wood Buffalo region (the study area).

SCOPE OF SEIA

The SEIA describes and assesses the:

- social and economic impacts of the Project's construction and operations on the study area, and ways in which Shell will mitigate any negative impacts and enhance positive impacts of the Project
- economic benefits of the Project on the provincial and national economy

The SEIA also:

- evaluates the Project effects on local and regional communities
- estimates the net social benefit associated with the Project
- analyzes the geographic distribution of construction expenditures

The SEIA did not evaluate the impacts of mining the resources in the Fort McKay First Nation lands adjacent to the Jackpine Mine Expansion. Because no commercial arrangements are currently in place, there is no basis for assessing the socio-economic impacts of mining these lands. If a commercial agreement were reached in the future, a full SEIA would be undertaken in support of any amendment to this application.

STUDY AREA

The SEIA study area is the Regional Municipality of Wood Buffalo (RMWB), which encompasses:

- Anzac
- Conklin

STUDY AREA (cont'd)

- Fort Chipewyan
- Fort McKay
- Fort McMurray
- Janvier
- Saprae Creek and Gregoire Lake Estates

The study area also includes the following reserve lands:

- Athabasca Chipewyan First Nation
- Chipewyan Prairie Dene First Nation
- Fort McKay First Nation
- Fort McMurray No. 468 First Nation
- Mikisew Cree First Nation

Where appropriate, the SEIA considered the Project's effects beyond the study area. For example, in assessing the economic effects of the Project, the SEIA considered the effect on the provincial economy.

APPROACH TO SEIA

The approach to conducting the SEIA consists of:

- identifying and screening potential issues
- selecting key indicators of socio-economic conditions
- defining spatial and temporal study area boundaries

ASSESSMENT CASES

The SEIA uses the same three assessment cases that were used in the EIA:

- Base Case, which consists of the study area's existing and approved projects
- Application Case, which consists of the Base Case plus the Project
- Planned Development Case, which consists of the projects in the Application Case, plus all other projects planned for the study area, provided that they have been disclosed at least six months before submission of the Project's regulatory application

SHELL'S ROLE

As the Project developer, Shell recognizes that its main role is to enhance the positive effects of the development by creating wealth through employment income, contracting revenue and government revenue. In addition, Shell has a critical role in mitigating the effects of oil sands industry expansion.

Shell is committed to:

- taking responsibility for areas that are directly under its control
- facilitating and advocating in areas that are not under its control
- providing resources for identifying and managing impacts, where appropriate

Project-Related Activities

Shell's understanding of its role is to focus on effects that are directly attributable to the Project, and that it can mitigate by adjustments to normal operations. This means:

- undertaking, where appropriate, targeted educational and contractor development initiatives to support positive effects
- avoiding, where possible, actions that exacerbate social issues, such as increasing traffic, or compromising the safety of communities
- undertaking employee education initiatives targeted at undesirable behaviour, including drinking and driving, speeding, and drug and alcohol use
- providing cultural sensitivity training in worker orientations
- limiting the costs of Shell employees on public systems through appropriate employee support programs, such as an employee assistance program

Non-Project-Related Activities

Shell recognizes that it contributes to economic and population growth in the region, and sees its corporate role extending to areas outside its normal sphere of operations. Activities in these areas will often be more indirect and facilitative, reflecting the indirect linkage between the areas of concern and the Project. Examples include:

- providing help to affected local agencies through a charitable donation policy and such initiatives as The United Way's Days of Caring
- facilitating volunteer commitments by its staff

Shell also recognizes a leadership role as an advocate for its employees and other affected people in dealing with municipal, provincial and federal departments and agencies. This could involve senior staff in regional initiatives, and Shell contributing financially to the initiatives, where appropriate.

REGIONAL ECONOMY

The regional economy is supported by four major industries:

- the oil sands industry
- forestry
- conventional oil and gas exploration and production
- tourism

Industry services provided include:

- transportation
- construction
- logistics
- wholesale and retail trades

Smaller economic activities in the region include:

- mineral exploration
- commercial fishing
- hunting and trapping

SOCIAL SETTING

Fort McMurray is the population and service centre of the region. Information from the Statistics Canada Census (1996, 2001) and the RMWB Census (1999, 2000, 2002, 2004 and 2006) indicates that the resident population of the region, including First Nations reserves, has grown from 37,222 in 1996 to 67,067 in 2006. This is an increase of 80% over 10 years.

Including mobile workers or non-residents, the population of the RMWB in 2006 was 78,788. The growth rate in the 10-year period from 1996 to 2006 was 114%. Most of this population has been concentrated in Fort McMurray, where the average annual growth rate from 1999 to 2006 was 8.5% (RMWB Census 2006).

The resident population accounted for 87% of the total number of people living in the Wood Buffalo region in 2006. The non-resident population, which comprises workers living temporarily in workforce camps in the area, accounted

SOCIAL SETTING (cont'd)

for another 10,442 people (RMWB Census 2006). The number of people living in workforce camps fluctuates with construction activities on projects.

REGIONAL ISSUES

Regionally, the key socio-economic issues are:

- employment and training
- population effects on local and regional service providers
- transportation and other infrastructure
- access to land and land use
- regional and provincial benefits

In addition to these key regional issues, First Nations and Métis issues and concerns include:

- access to education and training opportunities
- access to economic development opportunities
- the retention of Aboriginal culture
- physical infrastructure requirements
- safety

CONSTRUCTION EMPLOYMENT

Direct Construction Employment

Construction of the Project is expected to create 28,800 work years of employment for:

- construction workers on site and in fabrication yards
- construction supervisors
- construction engineers

An estimated 18,110 work years of on-site employment will include on-site craft workers and supervisors. This direct employment will also generate:

- indirect employment, or employment with Project suppliers

- induced employment, or employment in the economy from the personal spending of direct and indirect workers

The total direct, indirect and induced employment impacts are estimated at 69,320 work years during construction.

The on-site workforce is estimated to peak at about 3,000 workers in early 2015, during construction of the Jackpine Mine Expansion, and again at about 3,000 workers in early 2021 during construction of the Pierre River Mine.

Contracting Plan

The plant and mine will be constructed by contractors under Shell's supervision. For the mine, a minimal overlap will occur between the construction contractor's and the mine operations equipment fleet. The size and timing of the Project's construction workforce requirements is subject to change, as Shell is considering an accelerated execution scenario, which would advance the timing and increase the peak workforce requirements. If the Project's execution is accelerated:

- the Jackpine Mine Expansion might be executed between 2010 and 2013, overlapping, at least partly, with the construction of the Jackpine Mine – Phase 1

- the Pierre River Mine might be executed between 2014 and 2018

Contracting Plan (cont'd)

Under the accelerated scenario, the peak on-site workforce might reach 5,000 or more for a brief period. Under the Base Case of three years between start-ups, minimal overlap would occur.

Cumulative Construction Employment

If all projects in the Planned Development Case proceed as planned, the total number of construction workers in the region is expected to exceed 20,000 between 2008 and 2010. At the workforce requirement peak, the Project is estimated to account for about 25% of the total construction workers in the region. This assumes that all projects in the Planned Development Case will proceed.

If the Project's 10-year construction schedule is accelerated, it would likely overlap with other oil sands construction activity already planned or announced for the RMWB. The peaks would then occur between 2013 and 2014, and during 2019 or 2020. The accelerated execution might extend the period in which the number of construction workers in the region exceeds 20,000, to between 2008 and 2012.

OPERATIONS EMPLOYMENT

Direct Employment

The Jackpine Mine Expansion will continue to be integrated with the Muskeg River Mine to allow optimization and the economic, orderly and efficient development of the resource. The development plans for the Pierre River Mine will also maintain flexibility for integrating with the Muskeg River Mine and the Jackpine Mine.

The number of operations jobs will increase by about 2,130 full-time jobs, creating 2,130 work years of employment (see Table 18-1). The actual number of jobs will vary because of hauling distances and other operational considerations.

The main occupations required will be process and equipment operators. The Project is also expected to employ a wide range of maintenance workers permanently and on contract.

Local Hiring, Contracting and Business Development Practices

Shell's Good Neighbour Policy (see Section 15.1) will be extended to the Project's local hiring and procurement practices. These include:

- ensuring that jobs created by Shell are filled by its neighbours whenever possible, but always on a strictly merit basis
- using and encouraging local businesses, including First Nations and Métis businesses, if they are competitive and can meet Shell's requirements

Shell will also apply this Good Neighbour Policy to the activities associated with the Pierre River Mine. The Pierre River Mine will have an operations camp, and locally hired workers will be expected to reside in the camp during their shifts. Contractors will, as much as possible, be encouraged to reside in the camp, to avoid the health and safety concerns associated with the 120-km-long commute to and from Fort McMurray.

Shell is working with the neighbouring communities to increase the number of community members working directly for Shell. Shell has also initiated the Aboriginal Talent Pipeline, a program that aims to increase Aboriginal participation in its workforce.

Table 18-1: Operations Employment by Type

Employment Type	Work Years			Proportion of Total (%)
	Jackpine Mine Expansion	Pierre River Mine	Total	
Plant operations	270	460	730	34
Mine operations	360	710	1,070	50
General and administrative	120	210	330	15
Total	**750**	**1,380**	**2,130**	**100**

Note:

1. Totals might appear incorrect because of rounding.
2. Most jobs are all-year and full-time. Some job sharing might occur, resulting in the number of work years being about equal to the number of jobs.

Cumulative Operations Employment

Cumulative operations employment is the key driver for population growth in the region, which, in turn, drives many of the social impacts. The cumulative operations workforce associated with the oil sands industry in the RMWB, based on the Planned Development Case, is estimated to reach:

- over 20,000 workers in 2015, when the Jackpine Mine Expansion becomes operational
- about 25,000 workers in 2021, when the Pierre River Mine is fully operational

The contribution of the Project to the total operations workforce will be about 8%.

POPULATION

Urban Service Area

Figure 18-1 presents the three population forecast cases and shows that by 2015 the urban population could reach:

Urban Service Area (cont'd)

- 90,000 for the Base Case
- 98,000 for the Application Case
- 117,000 for the Planned Development Case

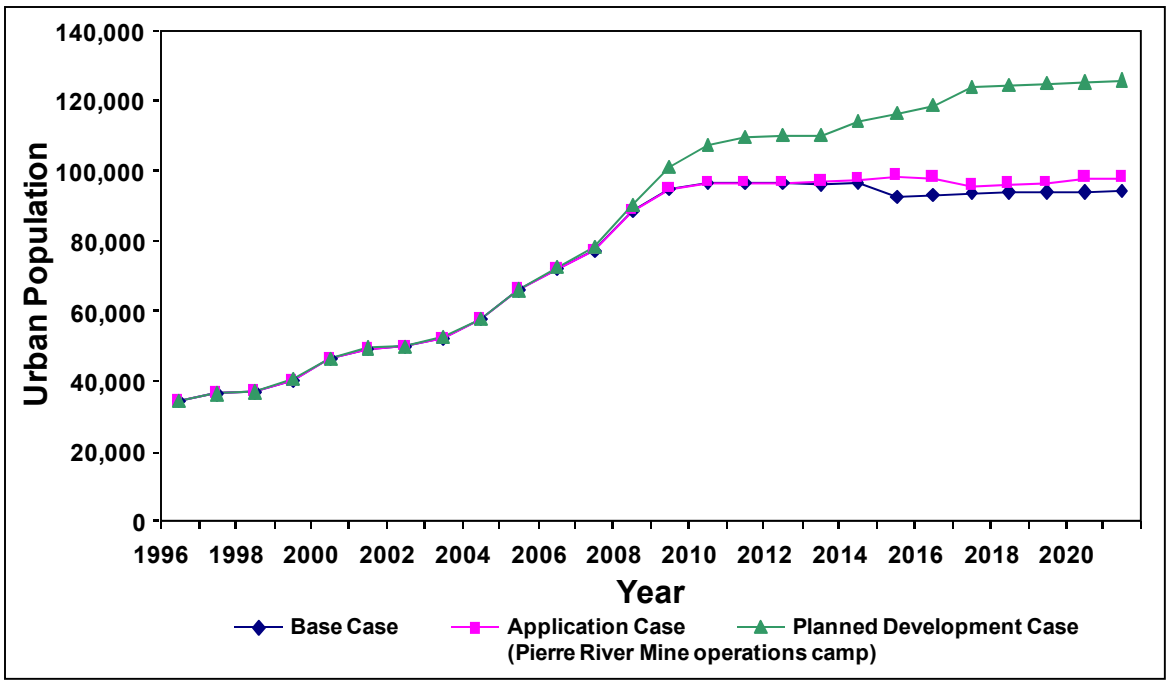


Figure 18-1: Urban Service Area Actual and Estimated Population

All three forecasts show a general slowing in the population growth because of changes in technology and operating models.

The maximum contribution of the Project to the cumulative population effect is estimated to occur:

- between 2015 and 2016
- between 2021 and 2022

Rural Service Area

Changes in the population levels in Fort McKay and the other rural communities in the RMWB are related mostly to community-level demographic pressures, which include:

- a young population, with a higher proportion of the female population currently of childbearing age or reaching that age in the near future, compared to that in Fort McMurray

- a mobile population, with people leaving the rural communities in search of employment opportunities and returning to their communities, partly to avoid high housing prices in the urban centres

The total rural population, including First Nations reserves, is estimated at 3,650 (see Table 18-2).

Table 18-2: Population Estimates for the Rural Service Area in 2006

Community	Population
Fort Chipewyan	1,090
Fort McKay	540
Anzac and Fort McMurray First Nation reserve	960
Conklin	340
Janvier and Chipewyan Prairie First Nation reserve	540
Other	180
Total	**3,650**
Sources: • Regional Municipality of Wood Buffalo, Census 2006 • Indian and Northern Affairs Canada 2006	

A key driver of population growth in these communities will be the rate at which new subdivisions can be completed to accommodate new migrants to the region.

Construction Workforce Camps

The 2006 municipal census identified 10,422 people living in workforce camps. The number of mobile workers reached 18,600 in May 2007. The level of construction activity for the Planned Development Case will likely require the same workforce number in camps for some time. However, it is uncertain if all projects in the Planned Development Case will go ahead as planned.

TRADITIONAL LAND AND CULTURE IMPACTS

Situation Analysis

Oil sands industry development is resulting in different types of pressure on the traditional lands and culture of Aboriginal people in the region, including:

- removing land from traditional land uses by means of mines, in situ field facilities, plant sites and transportation networks

- increasing the regional population, and increasing access to places that were previously difficult to access. This will likely increase competition for traditional resources.

Situation Analysis (cont'd)

- providing wage economy opportunities to local Aboriginal people, which will likely reduce their involvement in traditional pursuits

For the Project, and other projects included in the Planned Development Case, the area around Fort McKay will be the major hub for bitumen production in the province. Traditional land uses will be limited during these projects, which are currently planned to last until 2039 or 2049. In addition, other projects might be developed.

Project Mitigation

Shell recognizes that:

- traditional culture is important to Aboriginal people
- open pit mining is not compatible with traditional land uses until reclamation is complete
- increased competition for resources on traditional lands exists among First Nations

Therefore, to limit the Project's impact on traditional land use, Shell will:

- consult and cooperate with affected traditional resource users, to reduce the constraints to access and use their traditional lands, where possible
- work with local communities and other stakeholders to incorporate traditional environmental knowledge into mine planning activities, such as reclamation and end land use
- reduce the duration of the disturbance by incorporating early reclamation of lands into mine planning
- provide compensation to affected traditional resource users, based on an agreed-to impact assessment process
- negotiate agreements that incorporate measures to mitigate impacts on traditional lifestyles

Mine and end-land-use planning are within Shell's direct control. Therefore, Shell is in a position to act in close consultation with the communities.

Shell is committed to cultural sensitivity training of its non-Aboriginal staff and contractors, and to structuring work practices to allow for the cultural diversity of its workforce. Shell and Albian Sands are also undertaking several regional and community-specific initiatives to support the retention of Aboriginal culture, including:

- participating in the regional Traditional Environmental Knowledge Committee within the Cumulative Environmental Management Association (CEMA)

- supporting the collection of traditional ecological knowledge of medicinal plants, wildlife, and spiritual and cultural sites on the traditional lands of Fort McKay First Nation, Athabasca Chipewyan First Nation (ACFN), Mikisew Cree First Nation (MCFN) and Shell leases before their development

- supporting cultural retention programs, including:

    - Dene gatherings
    - Elder and youth programs
    - language retention initiatives
    - traditional knowledge videos

- supporting historical preservation initiatives, such as:

    - the Fort Chipewyan Museum
    - the Cree Burn Lake Education Project

- promoting the Quarry of the Ancestors, an archaeological site near Fort McKay, which is rich in artifacts

As community initiatives are identified, Shell will assist and contribute, where appropriate.

HOUSING IMPACTS

Situation Analysis

The Project and other planned oil sands developments will contribute to housing market pressures in the Wood Buffalo region.

If the population growth in the urban service area is as forecast in the Planned Development Case, the number of new dwellings required above the Base Case will be 10,870. However, the housing needs of the region might be less than envisioned in the Planned Development Case, depending on the outcome of a 2007 provincial land release strategy.

Affordable housing is also expected to remain scarce. The Wood Buffalo Housing Development Corporation has received about $18.5 million in grant funding from the Affordable Housing Investments Program (AHIP) for 700 units. However, an estimated 2,000 additional units will likely be required, both for renting and ownership, between 2005 and 2009.

Project Mitigation

Construction Phase

As with other oil sands facilities in the region, the Project will be built by construction workers who will be housed in on-site camps at the mines, or in third-party camps nearby.

Shell recently opened Albian Village at the Jackpine Mine – Phase 1 site. This facility, which at full capacity will provide accommodation for 2,500 workers, has:

- squash and racquetball courts
- a running track
- a workout facility
- a lounge
- a movie theatre
- a dining area
- a ball diamond
- an outdoor skating rink
- an internet cafe
- a coffee and doughnut shop

Albian Village will be the primary accommodation for construction tradespeople and engineering, procurement and construction management (EPCM) supervisors. Designed and built to last for 25 years, the camp housed 1,100 workers in October 2007, of which about 80% were craft labourers, consisting of carpenters, scaffolders, boilermakers, millwrights and pipefitters. The remaining 20% were construction and EPCM supervisors.

Shell expects to have commercial arrangements in place with one or more third-party camp providers. Currently, several camps are in the region. A new facility is expected to open in mid-2008, and the community of Fort McKay is one of the joint venture participants.

Operations Phase

The Jackpine Mine Expansion will not be supported by an operations camp. The Jackpine Mine Expansion's employees will be expected to live in Fort McMurray. Shell is working on housing issues with other developers and operators through the Regional Infrastructure Working Group (RIWG). As part of this initiative, Shell and the RIWG provide the real estate development industry with regular population forecasts and detailed information on the expected income levels and precise timing of new hiring. This information is being provided to enable the real estate development industry to react in a timely way.

Once operational, the Pierre River Mine will be supported by an operations camp. An operations camp will be constructed for the Pierre River Mine because of health and safety considerations. The mining area and facility are too far from

Fort McMurray for workers to commute daily. An estimated 90 to 95% of the operations workforce will be flown in and out for shift rotations, using the Albian aerodrome located about 10 km from the Jackpine Mine Expansion site. Workers residing in the study area will live in the on-site camp during shifts, and commute by bus or van between shifts.

Having an on-site camp will also reduce the Pierre River Mine's socio-economic impacts by:

- eliminating, or reducing, the need for operations staff housing in Fort McMurray. The operations workforce will contribute minimally, or not at all, to land release, housing pressures, education and social services, and municipal infrastructure pressures in Fort McMurray.
- avoiding increased daily commuter traffic on Highway 63

EDUCATION IMPACTS

Situation Analysis

According to Alberta Education statistics, the total enrolment in the public and separate school divisions within the RMWB during the 2006–2007 school year was 9,657 students. This represents a 3% growth over the previous school year, lagging behind the growth in the general population. School boards generally face uncertainty over enrolment, as families with school-aged children have been under-represented in the migration into the community.

Rural schools report additional issues, including low student performance, high dropout rates and students finding the transition to high schools in Fort McMurray difficult. Enrolment in Northland School Division schools in the study area was 530 students in the 2006–2007 school year. This is down marginally from 568 for the 2005–2006 school year. These numbers do not include students enrolled in e-learning initiatives.

Project Mitigation

Shell will continue to support the RIWG's commitment to the Urban Population Impact Model, which generates estimates of the population of the Fort McMurray service area, by age group. These estimates provide regional educational authorities with population estimates that can be used for planning.

Shell will continue to assess, and support where warranted, the following initiatives:

- RIWG and Athabasca Tribal Council–Athabasca Resource Developers education initiatives, including Aboriginal apprenticeship opportunities
- Keyano College, through financial donations

Project Mitigation (cont'd)

- e-learning initiatives, such as the Fort McKay E-Learning Centre, which has been operating since 2004, with Shell's support
- education initiatives identified by rural schools in the study area, as appropriate
- training programs and initiatives in First Nations communities
- Aboriginal scholarships, through:
  - providing financial contributions to the National Aboriginal Achievement Foundation
  - supporting environmental education of Aboriginal students in the region

An additional benefit of using an operations camp at the Pierre River Mine is to reduce the impact of the Project on school enrolment. Housing workers from outside of Fort McMurray in camps would mean that their families would not have to relocate to Fort McMurray, thereby reducing the number of children that might need to be enrolled in schools.

SOCIAL SERVICE IMPACTS

Situation Analysis

Local service providers have staff recruitment and retention issues, with funding formulae that do not reflect the realities of working and living in Fort McMurray. In addition, increased demands are being placed on their resources as a result of increased community stresses, such as:

- growing numbers of homeless looking for shelter and other support services
- work demands that take time away from family and community life
- reduced community cohesion and a sense of transience among residents
- high rates of alcohol and drug use and gambling

The Project's predicted contribution to the population growth in the region is marginal, with less than 6% during construction and about 4% during operations. The Project and other oil sands developments will lead to increases in population that will require additional social services in the RMWB. The increased demand for social services will require additional social facilities, programming and staffing.

Project Mitigation

During construction of the Project, Shell will:

- provide full-service camps, reducing the need for construction workers to live in Fort McMurray

- use extended work schedules, keeping workers busy while living in camp
- provide workers with lengthy periods of time off, allowing them to travel home to their place of residence between shifts

During the Operations Phase, Shell employees will have access to the company's confidential employee assistance plan. This plan provides support for families and individuals experiencing difficulty dealing with personal, family or work-life issues that can affect their health and well-being.

HEALTH SERVICE IMPACTS

Situation Analysis

Rapid population growth in the region has led to increased demands on health services, including services in small outlying communities. The ability of the system to meet this increased need is challenged by:

- the difficulty in recruiting and retaining health care professionals and support staff
- the provincial funding approaches that do not adequately address the high population growth rates of the RMWB and the health service demands of out-of-region residents
- the ongoing infrastructure needs, including a new continuing-care facility

Any effects to the health system in the Application Case will parallel those of the Base Case until about 2012, at which time the Project will start to contribute to the pressures on the health system. However, the Project's proposed on-site health centre is expected to be operational before 2012, and will:

- increase the number of health facilities and professionals in the region
- reduce the impact of Project construction and operations workers on the public health system

The Project and other planned oil sands developments will lead to increases in population that will require additional health services in the RMWB. The increase in demand for health services will require additional health facilities and staffing.

Project Mitigation

In summer 2007, Shell signed a Memorandum of Understanding with the Northern Lights Health Region to establish a more advanced on-site health care facility at the Albian Village site. This facility currently provides 24-hour on-site primary, emergency and occupational health care for occupational and non-occupational illnesses and injuries. Care is provided by nurses with advanced training and with 24-hour physician support, either by phone or on site.

Project Mitigation (cont'd)

A similar facility might be constructed at the Pierre River Mine. The key drivers behind these facilities are health and safety considerations. The facilities would also be expected to reduce the number of people from outside the region using emergency room services in Fort McMurray.

Other Shell initiatives to reduce the impact of the Project on health service providers include:

- financial contributions, where appropriate, to the Northern Lights Health Foundation to support the Northern Lights Health Region's efforts to meet the needs of Wood Buffalo residents
- continued support of RIWG's ongoing commitment to the Urban Population Impact Model as a way of supplying the health region with data for planning

POLICING AND EMERGENCY SERVICE IMPACTS

Situation Analysis

Public safety is a concern of local area stakeholders, the RMWB and the province, which pays for rural policing through the provincial policing contract. It is also a concern of other stakeholders, who have responded by adding resources to the urban and rural detachments of the RCMP. In mid-2007, the RCMP had a large number of positions relative to the population and other jurisdictions. Based on 2005 data (the last available), the urban detachment had one position per 688 people in the population, compared with the provincial average of one per 1,000 people. However, staff recruitment and retention issues cause actual staffing levels to lag behind the number of funded positions.

The Fort McMurray Fire Department is responsible for all emergency response calls within the boundaries of the RMWB, except for emergencies in Fort Chipewyan. The department provides support, as needed, to the Fort Chipewyan volunteer fire department. The Fort McMurray Fire Department's current urban staffing level consists of 116 fire and ambulance personnel, and 34 support and administration positions, located in four stations. The rural contingent, consisting of 100 volunteer firefighters, increases the total emergency response personnel to 250.

The Project and other planned oil sands developments will place additional burdens on emergency service providers in the RMWB, creating the need for additional personnel and infrastructure.

Project Mitigation

Shell's mitigation initiatives for emergency services are guided by the general statement that it will act, where it can, as part of its normal operating plan. Examples of current initiatives include:

- safety considerations in the design of all facilities. For example, including an extended runway, instrument landing capability and high-intensity lighting in the Albian aerodrome design.

- explicit and enforced camp, workplace and flight policies for illegal activities and using alcohol and drugs

- in-camp first-response medical services for workers, including having an on-site doctor and nursing staff

- an emergency response plan, including

    - integrated incident and crisis management teams
    - full-time certified emergency responders
    - auxiliary emergency response teams

Camp security is also part of Shell's mitigation. Generally, camp security would augment the total number of security resources in the region. Current and expected future practice indicates that company security forces assist the RCMP within, and sometimes outside, the Shell lease boundaries. Examples include securing accident scenes and assisting with highway closures.

Discussions about security arrangements at the Albian aerodrome are ongoing and involve Transport Canada. Using the Albian aerodrome as the main entry point for Pierre River Mine construction and operations workers will provide an opportunity for screening the workers upon their arrival in the region.

Shell will work with others to mitigate impacts that are mostly outside its direct control by:

- cooperating with the RMWB and other oil sands companies by maintaining or entering into mutual aid agreements that include:

    - responding to motor vehicle accidents on Highway 63

    - providing advanced life support and ambulance support to Fort McKay residents, including transfers to the Fort McMurray hospital

    - responding to forest fire threats to Fort McKay

    - responding to regional spills

    - participating in managing regional emergencies at the RMWB's Regional Emergency Operations Centre

- communicating its development and operational plans with the appropriate agencies

TRANSPORTATION IMPACTS

Situation Analysis

Oil sands expansion in the RMWB has led to increased traffic throughout the region and beyond. For example, traffic on Highway 63 between Fort McMurray and Suncor has increased from an estimated 6,570 vehicle movements per day in 2000 to 13,930 in 2006. This indicates that traffic more than doubled over six years. Collision rates are increasing on the main thoroughfares in the region (see Table 18-3). However, they remain below the provincial averages for similar roads.

Table 18-3: Highway Collision Rates

	1998 to 2002	2003	2004	2005	Provincial Collision Rate
Highway 63, north of Lougheed Bridge	44	40	39	36	110
Highway 63, Syncrude access to Lougheed Bridge	65	58	64	69	110
Highway 63, Suncor access to Syncrude access	44	46	56	60	110
Highway 63, Fort McMurray to Suncor access	46	45	51	51	57
Highway 63, from Highway 881 to Highway 55	61	68	79	87	110
Highway 881, Highway 63 to Anzac access	77	87	91	83	133
Highway 881, south of Anzac access	101	105	116	74	133

Source: Alberta Transportation and Nichols Applied Management

Note:

1. Collision rate is defined as the number of collisions per 100,000 vehicle kilometres.
2. Average provincial collision rates are for 2004, which is the last year available. The average collision rate for four-lane divided highways is 54. For two-lane highways it is 110, and for rural highways numbered 500 to 999 the rate is 133.

The Project will contribute to increased traffic impacts on Highway 63 north of Fort McMurray. The direct traffic impacts include vehicle movements to the plant sites during construction and operations. Indirect traffic impacts relate to activities of Shell employees and contractors outside working hours, e.g., Project employees and their families travelling south from Fort McMurray to Edmonton via Highway 63. The impact will be particularly noticeable on the highway north of the current Muskeg River Mine and Aurora Mine turnoffs, mainly because of the low traffic numbers there currently.

The Project and other planned oil sands developments will put additional pressures on transportation infrastructure and services in the RMWB.

Project Mitigation

The key transportation-related mitigation initiatives that Shell will implement are:

- using the Albian aerodrome, near the Jackpine Mine – Phase 1 site, as the primary transportation conduit for Project construction workers and Shell personnel. The aerodrome will be operational by the end of 2007. Compared to commuting to and from the site by bus and small vehicle, using the Albian aerodrome will:
    - reduce the Project's impacts on the weekend shift change traffic between Edmonton and Fort McMurray and areas to the north
    - provide a single access point, which will provide additional enforcement options for drug and alcohol policies
- using a construction camp at the Jackpine Mine Expansion and the Pierre River Mine to reduce construction workers' commute
- using Albian Village, near the Albian aerodrome
- planning project design, siting and routing, and adjusting hours of operation to avoid or limit impacts on the environment and neighbours. This will include combining plane and bus transportation to move operations workers to and from the mining areas. For example:
    - Fort McMurray-based operations workers will be transported by bus to the Jackpine Mine Expansion daily
    - operations workers at the Pierre River Mine will commute between shifts by bus or plane, depending on the home community
- scheduling heavy construction traffic in off-peak hours
- enforcing drug and alcohol policies for contractors and employees
- working with the local RCMP detachment in Fort McKay to ensure communication on local impacts
- training employees and evaluating contractors' driver safety programs to increase safety attitudes and driving competencies. Passing a driving safety course is mandatory for new employees who are expected to drive for the company. Contractors are expected to comply with Shell's policies.

These initiatives are directly within Shell's control and are examples of Shell's commitment to act where it can. Shell will also work with other developers and the RMWB to address transportation issues that are outside its direct control, such as:

- consulting and cooperating with other operators regarding scheduling shifts to reduce peak volumes of commuter traffic
- implementing initiatives of the RIWG, of which Shell is a member, regarding the east Athabasca Highway

MUNICIPAL SERVICE IMPACTS

Situation Analysis

The Project and other planned oil sands developments will put additional pressures on municipal services and infrastructure as they result in further population growth. Total non-residential assessment is expected to grow at over 10% per year over the next five years, expanding the RMWB's ability to pay for municipal services and infrastructure. The long-term financial viability of the RMWB is the subject of an ongoing study by the municipality, with support from Alberta Municipal Affairs and Housing.

Project Mitigation

Once the Project facilities are constructed, it will contribute to the assessment base of the municipality and will pay property taxes. The Project will provide its own water and sewer services for the different mining areas and the associated infrastructure, including camps. Beyond this, Shell is committed to working with the RMWB to keep it informed of Shell's development plans and timing. Shell is also an active participant in the RIWG, which provides ongoing information about the industry to the municipality.

EXPENDITURES

Construction

About 5% of the direct construction spending on labour, goods and services is estimated to accrue to, and thus constitute income for, local and regional companies and workers. The amount of total construction expenditures estimated to accrue to the region is limited, because most construction workers will be recruited from outside the region and most of the equipment and materials will be sourced from suppliers from outside the region.

The Alberta economy, including the RMWB, is expected to receive 40% of all construction expenditures, with an additional 25% accruing to the rest of Canada. The balance, or 30%, is expected to accrue to foreign suppliers.

Operations

Operations expenditures for the Project will begin with the start-up of the Jackpine Mine Expansion. At full production, annual operations expenditures for the Jackpine Mine Expansion will be about $260 million. Operations expenditures will further increase with the start-up of operations at the Pierre River Mine in 2018. At full production, the Project expenditures on labour and goods and services will be about $855 million per year. This includes expenditures on sustaining capital and plant turnarounds. Total operational expenditures will vary from year to year, depending on:

- the level of plant turnarounds
- sustained production levels
- variations in major input prices

On average, 20% of operations expenditures will accrue to workers and suppliers in the region. These numbers take into account that:

- many of the expenditures on goods and services by suppliers based in Fort McMurray are expected to have out-of-region components

- operations workers at the Jackpine Mine Expansion are expected to reside in the urban service area of the RMWB, whereas operations workers at the Pierre River Mine are expected to reside in the operations camp

Operations (cont'd)

In total, 73% of the annual operating expenditure, or $624 million, will accrue to the provincial economy.

Economic Impacts

The capital expenditure associated with constructing the Project constitutes income for contractors, suppliers and workers, who will spend part of their income on supplies and services, compounding the income impacts of the Project. Based on published multipliers (Alberta Treasury 2007), the direct, indirect and induced impact of the Construction Phase in terms of provincial gross domestic product (GDP) is estimated at between $12.4 billion and $19 billion.

As with the construction-related expenditure, the operations expenditure, including sustaining capital, is compounded by suppliers and workers purchasing a broad range of goods and services. Based on published multipliers (Alberta Treasury 2007), the direct, indirect and induced impact of the Operations Phase in terms of provincial GDP is estimated at $900 million annually.

GOVERNMENT REVENUE

During operations, the Project will provide economic benefits to the federal and provincial governments via royalty and corporate tax payments. The Project will pay an estimated $38 billion of taxes and royalties to the federal and provincial governments between 2008 and 2050. This is based on an average oil price of $50 (US) per barrel for West Texas Intermediate.

The benefits will accrue over time, which requires the future flow of benefits to be presented in net present value (NPV) terms and total terms. The NPV of the taxes and royalties will be about $5.5 billion between 2008 and 2050. On a NPV basis, the provincial government will receive $3 billion in royalties and taxes, and the federal government will receive $2.5 billion in corporate income and capital taxes. Table 18-4 shows the estimated tax and royalty payments to the provincial and federal governments between 2008 and 2050.

Table 18-4: Taxes and Royalties between 2008 and 2050 in 2007 Dollars

Taxes and Royalties	Total ($Million)	NPV at 8% ($Million)
Provincial royalty	17,560	1,660
Federal income and capital taxes	13,500	2,470
Provincial income taxes	7,400	1,350
Total	**38,460**	**5,480**

Note: Discount rate is 8% in real terms, or 10 to 11% in nominal terms. The discount rate was chosen to be a mid-point estimate between the long-term bond rate (about 5 to 6%) and the 10% discount rate used by many development banks.

PROVINCIAL GOVERNMENT RESPONSE

With the establishment of the Oil Sands Ministerial Strategy Committee and the action plan brought forward in the 2007 Radke Report, *Investing in our Future: Responding to the Rapid Growth of Oil Sands Development*, the Government of Alberta announced:

- funding initiatives of $396 million over three years to address:
  - health
  - infrastructure
  - affordable housing
  - municipal planning
  - child care access
- the establishment of an Oil Sands Sustainable Development Secretariat to address outstanding issues
- a commitment to twinning Highway 63 between Fort McMurray and the junction of Highway 55 near Grasslands
- a $1,040 monthly cost-of-living allowance to all employees working for provincially funded organizations in Fort McMurray
- the Municipal Sustainability Initiative (MSI), which will provide $400 million in unconditional grants to municipalities in the 2007–2008 fiscal year, increasing to $1.4 billion in 2010–2011. The RMWB is expected to receive about $223.9 million.
- a 10-year plan to coordinate initiatives that address homelessness in Alberta, through developing an Alberta Secretariat for Action on Homelessness. This plan is in the early stages of development, but might include $100 million annually in additional funding for homelessness initiatives.

FEDERAL GOVERNMENT RESPONSE

The Government of Canada is contributing to the cost of twinning Highway 63, and of an approved pilot project for employees of the RCMP to receive an annual living assistance payment of $9,400.

MUNICIPAL GOVERNMENT RESPONSE

The RMWB is increasing its borrowing, adjusting its tax policy and has announced that it will:

- provide an annual cost of living and wellness allowance for its staff
- implement a designated housing initiative that will provide:
  - transitional housing for new staff
  - a home equity protection program that will protect against a decline in real estate prices for at least three years
- have an operating budget of $204 million in 2007, which is a 230% increase from $88 million in 2003
- have a capital budget of $241 million, which is a 600% increase from $38 million in 2003

COLLECTIVE INDUSTRY RESPONSE

Oil sands industry companies are also responding to the growth pressures, both as individual companies and collectively. They are doing so through:

- the Athabasca Tribal Council–Athabasca Resource Developers All-Parties Core Agreement, providing support to the region's First Nations to increase their capacity to respond to the challenges of oil sands industry expansion. In 2007, the agreement was extended to 2010.
- participating in the RIWG, by providing:
  - population, housing demand and hiring forecasts
  - long-term urban population forecasts linked to production
  - mobile worker forecasts and surveys
  - oil sands industry assessment forecasts for municipal financial impact modelling

APPLICATION FOR APPROVAL OF THE PIERRE RIVER MINE PROJECT VOLUME 2: PROJECT DESCRIPTION

INTRODUCTION

PURPOSE

This section:

- addresses applications for industrial activities listed in the Activities Designation Regulation (Alberta Regulation 276/2003, consolidated up to 113/2006) Schedule 1, Division 2, Parts 8 and 9, Division 3 and Division 5, Schedule 2, Division 1
- provides the information required to support the application for the required approval

This section is organized to align with the information requirements in Sections 3(a)to 3(r) from the EPEA, Approvals and Registrations Procedure Regulation, Alberta Regulation 113/93 consolidated up to 251/2001, including amendments up to, and including, Alberta Regulation 216/96. Headings follow the numbering system used in the Guide to Content of Industrial Approval Applications, September 1999 (1.1 to 40.1)

EPEA APPROVAL REQUESTED

Shell is applying under Part 2, Division 2, of the *Environmental Protection and Enhancement Act* (EPEA) for approval to construct, operate and reclaim a mine and oil sands processing plant. Specifically, the approval is required to cover:

- an oil sands mining and extraction operation with development within Leases 9, 17, 351 and 309. Initially, mining is proposed to start on oil sands Lease 9 with facilities on oil sands Leases 9, 17, 351 and 309.
- an oil sands plant with bitumen production capacity of 31,800 m^3/cd (200,000 bbl/cd). Two processing trains will be used, each with a production capacity of 15,900 m^3/cd (100,000 bbl/cd).
- an external tailings disposal area (ETDA)
- cogeneration using a combination of natural gas and asphaltenes as fuel sources
- waste management facilities

EPEA APPROVAL REQUESTED (cont'd)

- a water supply, treatment and distribution system, including a water intake facility on the Athabasca River
- wastewater management facilities
- a bridge over the Athabasca River to provide access to the mine
- utilities and infrastructure to support the mine and processing facilities

REQUESTED APPROVAL PERIOD

This application includes information for the approval to construct, operate and reclaim mining and oil sands processing plant components as part of the Pierre River Mine. The requested approval for the Pierre River Mine is for a 10-year period, effective from the time the approval is issued for the operation.

3(a) NAME AND ADDRESS OF APPLICANT

1.1 Registered Company Name

Shell Canada Limited.

1.2 Mailing Address of Head Office (in Alberta)

The applicant's address is:

400-4th Avenue S.W.
P.O. Box 100, Station M
Calgary, Alberta T2P 2H5

1.3 Mailing Address of Applicable Plant or Regional Office

The applicant's mailing address is:

Shell Canada Limited
Oil Sands Division
400-4th Avenue S.W.
P.O. Box 100, Station M
Calgary, Alberta T2P 2H5

1.4 Phone and Facsimile Numbers, including e-mail

Mr. Michael Saretsky
Tel: (403) 384-5194
Fax: (403) 384-5130
e-mail: michael.saretsky@shell.com

1.5 Date

The date of this application is given in the transmittal letter at the front of this Volume, and is provided as part of this integrated application.

1.6 Names of Contacts for this Application

See Section 1.4.

1.7 Signature of Owner/Operator

The owner's signature is given in the transmittal letter at the front of this Volume.

3(b) LOCATION, CAPACITY AND SIZE

2.1 Legal Land Description

The location information provided here encompasses the Pierre River Mine development located in Townships 97 to 100, Ranges 10 and 11, W4M, more specifically:

- Twp 97-10 W4M – all or portions of Sections 31 and 32
- Twp 97-11 W4M – all or portions of Sections 35 and 36
- Twp 98-10 W4M – all or portions of Sections 5-8, 16-21 and 28-30
- Twp 99-10 W4M – all or portions of Sections 1-36
- Twp 100-10 W4M – all or portions of Sections 1-24
- Twp 99-09 W4M – all or portions of Section 31
- Twp 100-09 W4M – all or portions of Sections 5-8, 16-21 and 28-34
- Twp 98-11 W4M – all or portions of Sections 1, 2, 11-14, 23 and 24
- Twp 99-11 W4M – all or portions of Sections 1- 36

The Pierre River Mine development area is shown in Section 1, Overview, Figure 1-2.

2.2 Relation to Nearest Town, City or Village

The location of the proposed Pierre River Mine is about 100 km north of Fort McMurray, Alberta (see Section 1, Overview, Figure 1-1) and about 500 km northeast of Edmonton. Fort McKay is the closest community, and is located about 35 km to the south.

2.3 Geographical Description

Lease 9 is situated on the western bank of the Athabasca River, about 25 km north of the Muskeg River Mine, and 95 km north of Fort McMurray. Lease 9 holds the principal resource for the Pierre River Mine. Other resources in various stages of definition occur north of Lease 9, in Leases 17, 309, 310, 351 and 352. These leases are all held by Shell and occur along the west side of the Athabasca River as far north as Township 100.

Two major features dominate the physiography of the Pierre River Mine area. Birch Mountain to the west runs almost north–south, paralleling the trend of the Shell leases. Its height peaks at over 800 m, and decreases to 340 m over a distance of 5 km to the east. The Athabasca River trends north–northwest east of the Shell leases, and truncates a broad terrace 15 to 20 km wide. Within this distance, the elevation of the topography declines from 340 m at the foot of Birch Mountain to 250 m at the west bank of the Athabasca River.

East of Lease 9, the Athabasca River appears to have remained in the same 600-m-wide channel for much of its history. However, downstream to the north, the width of the floodplain broadens to over 8 km, indicating much channel movement.

The elevation of the floodplain plateau is between 250 and 260 m, compared with the elevation of the river water surface at about 225 m. The floodplain is defined by the surface of a series of islands and former islands. Coming out of a meander to the left, at the northeast corner of Lease 17, the Athabasca River is on the west side of the floodplain. About 18 km downstream, entering a meander to the right, just north of Lease 309, the Athabasca River has migrated across to the east of the floodplain.

Several minor watercourses enter the Athabasca River from the west, having flowed across the terrace from Birch Mountain. Some of them have eroded channels up to 30 m deep by the time they enter the Athabasca River. The Pierre River flows into the Athabasca River just south of Lease 9, Eymundson Creek enters the Athabasca River 6 km downstream, still in Lease 9, and Big Creek flows into an abandoned channel of the Athabasca River, midway along the east margin of Lease 351.

Muskeg, with some standing water, trends up the eastern side of Lease 17 to the western side of Lease 351. Cranberry Lake is about central to Lease 17, and Small Sandy Lake and Oakley Lake are located toward the west in Lease 351.

For a geographical and geological description of the Pierre River Mine, see Section 3, Geology.

3.1 Capacity of Processing Raw Material, By-Product and Finished Product

The Pierre River Mine will achieve a nominal production rate of bitumen from the development area of 31,800 m^3/cd (200,000 bbl/cd).

3.2 Other Appropriate Capacity Measurements

Electrical Power

The electrical power required for the Pierre River Mine will be between 160 and 200 MW per day. This power will normally be generated on site using a natural gas-fired cogeneration plant. A 115 MW asphaltene-fired cogeneration plant is currently being evaluated.

For more detailed information on electrical power, see Section 8, Utilities and Infrastructure.

Natural Gas

Normal operation of the Pierre River Mine will require 2,000 GJ/h of natural gas. However, the natural gas system will be sized to supply all of the gas-fired units with about 5,000 GJ/h. This will allow for maintenance of the asphaltene-fired boiler without affecting bitumen production.

Natural Gas (cont'd)

Natural gas will also be required for:

- the start-up and shutdown of the boiler in the asphaltene-fired cogeneration unit
- additional building heating
- blanket gas for the new process units

For more information, see Section 8.4 Auxiliary Utilities.

Water

Raw water for the Pierre River Mine will be supplied from the Athabasca River. The river intake structure will be located on the west side of the Athabasca River, 3 km north of Sled Island. A bank-style intake structure, which will be sized for a maximum withdrawal rate of 4.72 m^3/s, will be used.

Potable water for the Pierre River Mine Project will be withdrawn from the Athabasca River. Water from the Athabasca River will be treated in a potable water plant that will include ultrafiltration (UF) units, and a reverse osmosis (RO) train to provide water of a quality that meets or exceeds the quality levels recommended in *Canadian Drinking Water Quality Guidelines*. The Pierre River Mine potable water plant will be sized to accommodate the needs of the construction camp, and the potable water needs of the mine facilities.

The estimated domestic sewage flow from the construction camp is 750 m^3/cd. This will reduce to 150 m^3/cd during operations.

For more information on water, see:

- Section 8.2, Water Systems
- Section 10, Water Management

4.1 Size of Affected Area

The Pierre River Mine will have a mining disturbance area of 9,200 ha located in Leases 9, 17, 351 and 309. For the application, mining operations will be restricted to Lease 9.

For further information, see Section 20, Conservation and Reclamation Plan.

4.2 Physical Dimensions of the Plant Site

See Section 6, Ore Processing, for plot plans showing the physical dimensions of the plant site.

4.3 Number of Employees

The estimated workforce at the Pierre River Mine will be 1,380 workers during operations. The on-site workforce is estimated to peak at about 3,000 workers during construction. The number of jobs will vary because of hauling distances and other operational considerations. For further information, see Section 18, SEIA Summary.

3(c) NATURE OF THE ACTIVITY

5.1 Classification of Facility

The Pierre River Mine is classified under the Activities Designation Regulation AR 276/2003, as follows:

- Schedule 1, Division 2, Part 8, (h) ii, for an oil sands processing plant
- Schedule 1, Division 2, Part 9, i, for a power plant
- Schedule 1, Division 3, (a), for a mine
- Schedule 1, Division 5, (a) iii, potable water described in an industrial development
- Schedule 2, Division 1, (c), landfill

The Pierre River Mine includes other ancillary components that Shell expects will be covered by a combined approval, according to Section 6 of the Activities Designation Regulation.

Project components and regulatory approvals are described in more detail in:

- Section 1, Overview
- Section 5, Mining
- Section 6, Ore Processing
- Section 7, Tailings Management
- Section 8, Utilities and Infrastructure
- Section 10, Water Management

5.2 General Purpose, Raw Materials, Products and By-Products

The Pierre River Mine development includes:

- a truck-and-shovel mining operation
- a relocatable crushing and conveying system to size and transport material to an ore processing plant
- a processing plant that uses a warm (40 to 50°C) water-based, ore conditioning and extraction process, and a high-temperature paraffinic solvent-based froth treatment process for product cleanup

5.2 General Purpose, Raw Materials, Products and By-Products (cont'd)

- a tailings management scheme that uses an external area for initial tailings disposal, converting to non-segregating tailings production and the initiation of in-pit storage
- cogeneration plants fuelled by natural gas and asphaltenes, to produce both electrical power and steam
- utilities including:
  - a new Athabasca River raw water intake
  - a new raw water storage facility
  - natural gas-fired process water heating
  - electrical power and heated process water from the cogeneration plants
  - a Pierre River Mine-owned electrical distribution line that runs west and northwest from the plant site to the mining and tailings areas
- other infrastructure, including:
  - an access bridge over the Athabasca River
  - raw water and recycle water systems
  - hot water and steam generation
  - product and solvent tankage
  - cooling towers

Table 19-1 summarizes the Pierre River Mine raw materials, products and by-products.

Table 19-1: Pierre River Mine Raw Materials, Products and By-Products

Major Materials	Pierre River Mine
Natural gas	1,000–4,500 GJ/h
Steam	1,600 kg/h
Raw water	3,000 m^3/h
Solvent	65,000 L/d
Flocculent	10,000 kg/d
Defoamer	1,500 L/d
By-Product	
Tailings	29,686 t/sh
Product	
Bitumen	200,000 (bbl/d)

These quantities are based on a 31,800 m^3/cd (200,000 bbl/cd) mine plan. For additional information, see:

- Section 1, Overview
- Section 5, Mining
- Section 6, Ore Processing
- Section 8, Utilities and Infrastructure

5.3 Major Unit Operations

Major units required for each ore processing train at the Pierre River Mine are described. in this topic.

The ore preparation system will include:

- two new 14,000 t/h double-roll crushers
- a surge conveyor
- a dry surge bin
- two reclaim apron feeders
- two breaker feed conveyors
- two rotary breakers
- a rejects handling system

The primary extraction process will consist of a:

- primary separation cell
- series of primary flotation cells
- froth deaerator

The tailings treatment plant will consist of:

- a scalping screen
- tailings flotation cells
- cyclones
- a fine tailings thickener
- a tailings disposal system

The froth treatment train will use a high-temperature paraffinic froth treatment process, consisting of a:

- froth storage tank
- two-stage high temperature CCD process
- vapour recovery unit

The solvent recovery unit will be a single train designed to partially recover solvent contained in the diluted bitumen product from the first-stage settling vessel overflow of the high-temperature froth treatment process. The solvent recovery unit will consist of:

- a feed heater
- a flash column
- an overhead system
- product coolers

5.3 Major Unit Operations (cont'd)

The asphaltene recovery circuit separates asphaltenes, water, mineral solids and solvent in the tailings solvent recovery unit stream. The circuit consists of the following process units:

- gravity separation
- asphaltene dewatering
- tailings thickening and water recovery
- solvent recovery

Major unit operations for the Pierre River Mine are more fully described in:

- Section 5, Mining
- Section 6, Ore Processing
- Section 7, Tailings Management

5.4 Project Schedule, Production Facilities, Environmental Protection and Control Systems and Costs

The Pierre River Mine will mine and process oil sands in two process trains at a combined bitumen production rate of 31,800 m^3 (200,000 bbl/cd) and with an expected operating life of 22 years. The mining and process methods will be similar to those used at the Muskeg River Mine.

Environmental protection and control systems and procedures for the Pierre River Mine will be used, when required, to meet all appropriate regulatory limits and guidelines. For additional information, refer to Item 5.13 later in this section, and Section 1, Overview.

5.5 Drawings and Diagrams of the Plant, Plant Site and Surrounding Area

Engineering drawings, equipment specifications or other project details required by Alberta Environment (AENV), but which are not yet available, will be submitted when they become available during the project's detailed engineering phase.

Information provided with this application includes:

(a) a topographic map (see Section 3, Geology, Figure 3-1)

(b) property boundaries and land use of the area (see Section 1, Overview, Figure 1-2)

(c) the location of the plant site (see Section 1, Overview, Figure 1-2)

(d) the location and types of buildings for the Pierre River Mine (see the site plot plan in Section 1, Overview, Figure 1-6, and Section 8.6, Auxiliary Buildings)

(e) the locations and names of all known equipment to be used in the process (see Section 1, Overview). For further information see:

- Section 6, Ore Processing
- Section 8, Utilities and Infrastructure

The location of the cogeneration facilities is shown in Section 1, Overview, Figure 1-6. The known equipment used in the cogeneration facilities is identified in Section 8, Utilities and Infrastructure.

(f) air emission point sources for the Pierre River Mine (see Section 1, Overview, Figure 1-6). Air monitoring programs are described in the EIA, Volume 3, Section 2, Summary of the EIA and SEIA. Further details on air emission point sources are provided in Item 5.8, later in this section.

Process-affected water or industrial wastewater will not be released during operations of the Pierre River Mine. During clearing activities before mining, muskeg and overburden dewatering water will be released to the environment via sedimentation ponds when applicable release criteria are met.

(g) the equipment used to control, treat and dispose of waste (see Section 8, Utilities and Infrastructure and Section 11, Waste Management). The location of the landfill is still being evaluated.

(h) information on the sanitary sewage system.(see Section 8, Utilities and Infrastructure). The location of sanitary sewer lines will be determined during detailed engineering.

(i) information on process-affected water and runoff from the mine areas and plant site. Water from these sources will be directed to the recycle water pond and will not be released to the environment.

Muskeg and overburden will be drained to prepare the areas for stripping and mining operations. Water from muskeg and overburden dewatering might contain suspended solids. Therefore, this water will be routed through sedimentation (polishing) ponds before it is released to receiving streams. No water will be released until applicable regulatory release criteria are met.

For further information, see Section 10, Water Management.

(j) the location of air emission discharge points for the Pierre River Mine (see the facilities plot plan in Section 6, Ore Processing).

(k) the location of reclamation material stockpiles during the first 10 years of operation (see Section 20, Conservation and Reclamation Plan).

5.6 Flow Diagram of Process, Treatment Facilities and Equipment Capacities

For process flow diagrams, unit capacities and general descriptions of the major unit operations see:

- Section 1, Overview
- Section 5, Mining
- Section 6, Ore Processing
- Section 7, Tailings Management
- Section 8 , Utilities and infrastructure
- Section 10, Water Management
- Section 11, Waste Management

5.7 Products and Material Balance

Section 9, Material and Energy Balances, provides:

- an overall material balance for a bitumen production rate for the Pierre River Mine of 31,800 m^3/cd (200,000 bbl/cd)

- energy and heat balances

A water balance is provided in Section 10, Water Management.

Further details required by AENV, but which are not yet available, will be submitted when they become available during detailed engineering.

5.8 Industrial Wastewater Discharges and Air Emission Streams

Sources of industrial (process-affected) runoff water are:

- the plant site, including the ore preparation area
- the external tailings disposal area
- mine pit runoff and drainage

During operations, runoff from these sources will be collected within a closed-circuit system and used in the process. Runoff from the plant site will be collected with the treated plant wastewater and sent to the process water recycling pond. Ditches that are designed and built to avoid ponding will collect the on-site road drainage within the plant and ore preparation areas. Culverts will be provided at road crossings. The water will be treated in sedimentation ponds to remove oil before being mixed with the closed-circuit industrial water system for recycling.

Muskeg and overburden will be drained to prepare the areas for stripping and mining operations. Quantities and quality of muskeg and overburden water will vary with the characteristics of the material being drained. Therefore, all water drained from muskeg and overburden will be routed through sedimentation (polishing) ponds and controlled discharge points. No water will be released to receiving streams until applicable regulatory release criteria are met.

Detailed information on water management is provided in Section 10, Water Management.

(a) Continuous emissions to air will result from:

- combustion by-products from natural gas-fired and asphaltene-fired devices, such as cogeneration units
- combustion by-products from burning diesel and gasoline fuel in the mine fleet vehicles
- fugitive emissions from the mine face, external tailings disposal area and in-pit tailings disposal areas

Table 19-2 provides an overview of the emission release rates from the Pierre River Mine. The emissions are based on expected bitumen production.

(b) Table 19-3 provides the physical characteristics of air emission point sources.

(c) Table 19-2 provides the release volume per unit time data.

(d) All air sources, except for the auxiliary boilers and emergency flares, are continuous.

Flare specifications are discussed in Item 5.22, later in this section.

Table 19-2: Air Emissions from Pierre River Mine Point Sources

Source	Maximum Emissions Quantity of the Contaminants [1]						
	SO_2		NO_x		CO	VOC	$PM_{2.5}$
	(kg/h)	(kg/d)	(kg/h)	(kg/d)	(kg/h)	(kg/h)	(kg/h)
Natural gas-fired cogeneration unit	0.49	11.79	93.35	2,240.35	59.34	2.25	4.96
Asphaltene-fired cogeneration unit	169.71	4,073.07	120.55	2,893.17	160.68	6.70	7.43
Auxiliary boiler [2]	0.23	5.57	17.31	415.32	28.13	1.84	2.55
Auxiliary boiler [2]	0.23	5.57	17.31	415.32	28.13	1.84	2.55
Auxiliary boiler [2]	0.23	5.57	17.31	415.32	28.13	1.84	2.55
Note *: Predicted emissions for the auxiliary boilers are provided even though they are not sources of continuous air emissions.							

Table 19-3: Physical Characteristics of Pierre River Mine Air Emission Point Sources

Source	Stack Height (m)	Stack Diameter (m)	Effluent Stream Temperature (K)	Effluent Stream Exit Velocity (m/s)	Easting (m)	Northing (m)	Base Elevation (m)
Natural gas-fired cogeneration unit	40.0	4.3	360	23.0	465,980	6,376,404	266.6
Asphaltene cogeneration unit	150.0	4.5	328	20.0	465,946	6,376,782	269.7
Auxiliary boiler	40.0	2.7	436	21.9	466,108	6,376,675	266.6
Auxiliary boiler	40.0	2.7	436	21.9	466,115	6,376,689	266.6
Auxiliary boiler	40.0	2.7	436	21.9	466,122	6,376,702	266.6

5.9 Other Component Streams

For further information on air quality, including release volumes, concentrations and characteristics of component streams, see EIA, Volume 3, Section 3, Air Quality.

5.10 Cooling Systems

For information on cooling systems, see Section 8.1, Water Systems.

5.11 Raw Water Treatment, Chemicals and Associated Waste

Water will be required for:

- process operations
- gland water

Generally, water will be supplied from:

- the Athabasca River
- connate water contained within the oil sand
- tailings reclaim water
- groundwater obtained from dewatering the basal aquifer
- surface runoff

A new water treatment plant at the Pierre River Mine site will supply softened boiler makeup water to the steam generation plant. The makeup water is required to replace steam condensate lost in the TSRU and continuous boiler blowdown. The plant inlet feed will be raw water from the raw water pond.

The water treatment plant will include clarification, filtration, cation and anion, and mixed bed exchangers for demineralized water production. The plant will

also include the handling and storage equipment required for regeneration chemicals and effluent

For detailed information, see:

- Section 8, Utilities and Infrastructure
- Section 10, Water Management

Potable Water Treatment

Water from the Athabasca River will be treated in a potable water plant that will include ultrafiltration (UF) units and a reverse osmosis (RO) system to provide water of a quality that meets or exceeds the quality levels recommended in the *Canadian Drinking Water Quality Guidelines*.

The Pierre River Mine site potable water plant will be sized to accommodate the needs of the construction camp, as well as potable water needs of the mine facilities. Potable water for the Pierre River Mine will be withdrawn from the Athabasca River.

Water withdrawn from the Athabasca River is subject to periods of high total suspended solids (TSS) and organic content. The ultrafiltration membranes reduce the TSS in the river water feed to less than 1 nephelometric turbidity unit (NTU), and optimization of coagulation is used to reduce organic contaminants by up to 75%.

For further information, see Section 8, Utilities and Infrastructure and Section 10, Water Management.

5.12 Sanitary Waste Treatment and Disposal

(a) A sanitary sewage treatment plant will be designed and constructed on site to handle domestic sewage during construction (3,000 workers at peak) and during the life of the mine (1,380 workers).

(b) The estimated domestic sewage flow from the construction camp is 750 m^3/cd and will reduce to 150 m^3/cd during operations.

(c) During construction and operations, the sewage system will include a treatment plant and a sludge press. The resulting dry sludge will be hauled to a landfill for disposal and burying. Liquid effluent will be directed to the recycle pond.

The treated effluent will be piped through an existing underground forced main to the recycle water pond. Dry sludge from the sludge press will be hauled to an approved disposal site.

For additional information on the wastewater treatment plant, see Section 10, Water Management.

5.13 Major Environmental Control Operations

Scope

An overview of the major environmental controls applicable to the 10-year EPEA period is provided here for:

- air
- groundwater
- surface water hydrology
- surface water quality
- terrestrial resources
- landfill
- storage area for hazardous and liquid waste
- hydrocarbon control systems
- oily water sewer

Air

Environmental controls for air will include the following:

The cogeneration units for the Pierre River Mine Project will meet the Canadian Council of the Ministers of the Environment (CCME) emissions criteria for stationary combustion turbines (CCME 1992) and AENV's *Alberta Air Emission Standards for Electricity Generation*. The cogeneration units and auxiliary boilers will also meet AENV's *Emission Guidelines for Oxides of Nitrogen (NO_x) for New Boilers, Heaters and Turbines using Gaseous Fuels Based on a Review of Best Available Technology Economically Achievable (BATEA) – Interim Guideline*.

The following emissions control efficiencies will be implemented for the asphaltene-fired cogeneration units:

- SO_2 control efficiency of 99%
- NO_x control efficiency of 75%
- PM control efficiency of 99.97%

Above-ground storage tanks will conform to CCME's *Environmental Guidelines for Controlling Emissions of Volatile Organic Compounds from Above-ground Storage Tanks*.

Plant-wide fugitive emissions will be identified and controlled using the protocol recommended by the *Canadian Association of Petroleum Producers* (CAPP) *Management of Fugitive Emissions at Upstream Oil and Gas Facilities*, as well as other relevant guidelines and codes of practice aimed at minimizing fugitive emissions.

Flaring will be minimized, such as for upset or emergency conditions, start-up and commissioning, and will comply with EUB Directive 060. Vehicles in the mine fleet will meet applicable emission standards at the time of purchase.

Mine maintenance procedures will ensure that fleet vehicles are regularly maintained.

Tailings solvent recovery unit (TSRU) tailings deposition will be managed to maintain an annual average rate of 4 volumes of solvent per 1,000 volumes of bitumen produced.

Slash burning will be managed according to ASRD's regulations and to Shell's Environmental Management System (EMS) procedure and by continuing to coordinate slash burning with other operators in the region.

Road dust during dry periods will be managed during construction and operations by watering or other dust suppression methods.

Groundwater

To help mitigate potential effects of project activities on groundwater resources and ecological features linked to groundwater resources, the following measured will be taken:

- tailings will be placed below the top of the McMurray Formation or behind low-permeability barriers, such as dykes
- non-segregating tailings (NST) pit backfill will be separated from Quaternary sand and gravel deposits by a layer of low-permeability material
- seepage from the ETDA will be intercepted, captured and recycled
- seepage from the backfilled cells will be intercepted and captured through the closed-circuit drainage system and will be recycled during operations

For more detailed information, see EIA Volume 4, Section 6.3, Hydrogeology.

Surface Water Hydrology

The Pierre River Mine conceptual water management plan for the operations phase (see Section 10, Water Management) includes various design features, mitigation measures and best management practices to achieve the environmental management objectives for operations drainage for:

- minimizing effects on flows and water levels in receiving streams and lakes by distributing muskeg drainage operations through the mine life, thereby avoiding a large increase in flows in the receiving streams
- minimizing sediment loading to receiving streams and lakes by routing muskeg drainage and overburden dewatering to sedimentation ponds, equipped with oil separation capability, where required, before release to the receiving streams
- minimizing the effects of closed-circuit operations on flows and water levels in receiving streams and lakes by diverting natural streams, which will not be

Surface Water Hydrology (cont'd)

disturbed by the mining operations, around the mining area to receiving streams.

The closure drainage systems proposed for the Pierre River Mine include one pit lake, one habitat compensation lake and one water quality treatment pond that will discharge directly to the Athabasca River.

The drainage systems are designed to achieve the environmental management objectives of:

- minimizing effects on flows and water levels in receiving streams and lakes by developing a drainage layout
- minimizing sediment yields from reclaimed surfaces by developing final topography and soil moisture conditions
- minimizing gully and channel erosion by developing robust and self-sustaining reclamation drainage systems with built-in self-healing capability and robustness similar to natural drainage systems
- designing watercourses, waterbodies and wetlands during reclamation for attenuating floods and for bioremediation of tailings porewater releases, groundwater seepage and runoff from the reclaimed areas

The closure drainage systems will be constructed to be self-sustaining, similar to natural systems. The Pierre River Mine pit lakes are predicted to start to release in 2049.

For more detailed information, refer to EIA Volume 4, Section 6.4, Surface Water Hydrology and Volume 4, Appendix 4-9, Aquatics Monitoring.

Surface Water Quality

Environmental controls for surface water quality will include:

- implementing a closed-circuit water management and recycling system for process-affected waters during operation
- directing muskeg and overburden drainage waters to sedimentation ponds before release into receiving surface waters
- constructing perimeter ditches around ETDAs to capture and pump tailings pond seepage back into the pond during operation
- directing tailings pond seepages which are not captured by perimeter ditches to wetlands with sufficient residence time for natural treatment of organic constituents and to reduce associated tainting potential and whole effluent toxicity

- placing in-pit deposits below the top of the adjoining lean oil sands layer or behind low-permeability material to minimize potential seepage into receiving surface waters

- designing self-sustaining closure drainage systems that direct mine water releases to wetlands and pit lakes before being released to existing watercourses and waterbodies

- continuing to operate perimeter wells around the ETDA, that are active during the operational period, during the decommissioning and closure periods, as described in EIA Volume 4, Section 6.3, Hydrogeology

For further information on environmental controls through monitoring programs for aquatic resources, see EIA Volume 4, Appendix 4-9, Aquatics Monitoring.

Terrestrial Resources

Specific mitigation measures that will minimize the effects of the Pierre River Mine Project on terrestrial resources, wetlands and biodiversity during construction include:

- avoiding clearing between April 1 and August 30 to avoid the main breeding bird and ungulate calving seasons

- constructing straight roads with long sight lines, where feasible

- leaving remnant forested areas undisturbed, where practical

- providing construction staff with environmental awareness training as part of their on-site orientation

- contacting Alberta Sustainable Resource Development (ASRD), Fish and Wildlife, to assist in removing hibernating black bears if they are accidentally disturbed

- implementing regulatory-standard soil handling, management and storage practices.

Specific mitigation measures designed to minimize the effects of the project during operations include:

- maintaining a 250-m-wide wildlife corridor along the Athabasca River from the wetted edge in the 100 year flood event

- providing for wildlife passage under the Athabasca River bridge on both the east and west banks of the river

- designing lighting to reduce light pollution in the adjacent wildlife corridor

- fencing the approaches to the Athabasca River bridge

Terrestrial Resources (cont'd)

- retaining treed buffers around or near watercourses
- planning and sharing access with other industrial partners
- storing all food wastes in bear-proof containers before transporting it off site
- providing project staff with environmental awareness training as part of their on-site orientation
- posting wildlife crossing signage where key wildlife crossing areas are identified
- reducing traffic volumes by transporting staff to site using buses
- enforcing traffic speed limits
- undertaking dust control on roads
- deploying and maintaining bird deterrent systems
- using markers, such as aviation spheres, to mark transmission lines, particularly those located above the treeline or in clearings
- implementing a weed control system for the project area

The key mitigation methodology to minimize residual effects on terrestrial resources, wetlands and biodiversity is reclamation. The Conservation and Reclamation (C&R) Plan is detailed in Section 20 and the Closure, Conservation and Reclamation (C,C&R) Plan is detailed in EIA, Volume 5. The basic end land use goals that form the foundation of the C,C&R Plan include:

- reclaiming the landscape to an equivalent capability and optimizing the value of watershed, forest productivity, fish and wildlife habitat or traditional use, in consultation with key stakeholders
- designing for reclaimed landforms to include diversity and micro-topographic relief
- reclaiming and revegetating progressively
- revegetating according to the reclamation guidelines prepared by the Cumulative Environmental Management Association (CEMA) Reclamation Working Group
- building structures that will be geotechnically stable
- discharging earth materials through surface erosional processes that will be controlled at rates that are environmentally acceptable

- discharging surface and seepage waters that will be managed to ensure an acceptable level of impact on watercourses

- re-establishing ecosystems on disturbed lands so that they will be self-sustaining and will mature naturally without presenting significant risk to plants, or resident and migratory wildlife species

The final reclamation design will be completed in consultation with ASRD, forestry rights holders and local stakeholders. For more information on monitoring and participation in regional initiatives, see:

- Section 20, Conservation and Reclamation Plan
- EIA Volume 5, Section 7, Terrestrial Resources
- EIA Volume 5, Appendix 5-2, Pierre River Mine C,C&R
- EIA Volume 5, Appendix 5-6, Terrestrial Monitoring

Landfill

The Pierre River Mine waste management facilities will include:

- an on-site Class III landfill for disposing of inert solid waste
- a hazardous waste storage area
- a sanitary sewage treatment plant

Inert solid waste will either be recycled or disposed of in the Pierre River Mine Class III landfill. For further information, see Section 11, Waste Management.

Storage Area for Hazardous and Liquid Waste

Class IA and IB waste will be stored in properly designed containers and drums at a secure facility at the mine site. The stored materials will be removed regularly and transported to an approved off-site disposal centre. The design of the Pierre River Mine storage facility will comply with the *Guidelines for Storage of Hazardous Material*. For further information, see Section 11, Waste Management.

Hydrocarbon Control Systems

In normal operations, hydrocarbon liquids will not be released from process piping or process equipment. Releases that could occur during maintenance activities requiring equipment or piping to be opened will be minimized by standard operating practices, such as purging and gas freeing. Collection and containment systems will be provided to ensure that no hydrocarbon liquid will be released outside of the process area. Hydrocarbon entering these systems will ultimately be recycled to the appropriate point in the process.

Oily Water Sewer

Potentially oily water will be collected from floor wash, runoff and trenches in the fuelling station and plant maintenance building and routed to local sumps.

Oily Water Sewer (cont'd)

Sumps will be emptied by vacuum truck and the oily water will be transported to the tailings pond or to a regulated waste disposal facility.

For the Pierre River Mine, a waste contractor's vacuum truck will transport bulk volumes of non-hazardous liquid waste to the tailings pond. All other non-hazardous liquid waste materials will be piped directly to the recycle water pond.

For further information, see Section 11, Waste Management.

5.14 Underground and Above-Ground Tanks

No underground tanks are required for the Pierre River Mine. Table 19-4 shows the above-ground storage tanks that will support the Pierre River Mine.

Table 19-4: New Pierre River Mine Above-Ground Storage Tanks

Contents	Number of Tanks	Capacity (m^3)	Size diameter x height)	Secondary Containment	Leak Detection
Basal water booster surge tank	1	32	3.5 m x 3 m	Yes	Yes
Glycol tanks	4	15.89	3 m x 2.5 m	Yes	Yes
Wash water tanks	2	250	6 m x 7 m	Yes	Yes
Warm process water tanks	2	4,400	18 m x 19 m	Yes	Yes
Froth tanks	2	22,000	28 m x 45 m	Yes	Yes
Screen wash tanks	2	27	2 m x 5 m	Yes	Yes
Froth treatment area closed hydrocarbon drain tanks	6	20	5 m x 5 m	Yes	Yes
TSRU defoamer tanks	2	52.7	3.7 m x 6.1 m	Yes	Yes
Potable water storage tank	1	750	10 m x 10 m	Yes	Yes
Diesel storage tanks	4	364	9 m x 6 m	Yes	Yes
Solvent storage tanks	2	40,000	62 m x 16 m	Yes	Yes
Dilute bitumen product tanks	2	50,000	69 m x 16 m	Yes	Yes
Tank farm sumps	2	6	2.4 m x 5 m	Yes	Yes
Treated water storage tanks	2	2,400	15 m x 14 m	Yes	Yes
Hot water storage tanks	2	4650	22 m x 17 m	Yes	Yes
Emergency generator diesel storage tanks	2	15	2.6 m x 3 m	Yes	Yes

5.15 Underground Storage Tanks Testing, Inspection and Prevention of Overfilling

No buried process or storage tanks will be provided for the Pierre River Mine.

5.16 Potable Water

For information on potable water, see Item 5.11, earlier in this section.

5.17 Reciprocating or Turbine Engines

Table 19-5 provides the turbine specifications for the natural gas-fired cogeneration plant.

Table 19-5: Natural Gas-Fired Cogeneration Unit – Turbine Specifications

Source	Natural Gas-Fired Cogeneration Unit – Turbine
Maximum energy input (kW)	300,000
Maximum energy output (kW)	100,000
Stack height (m) [1]	40.0
Stack diameter (m) [1]	4.3
Exhaust gas temperature (°C) [1]	87
Exhaust gas velocity (m/s) [1]	23.0
NO_x emissions rate g/(kW*hr) [2]	0.5
NO_x emissions (t/d)	1.20

Note:

1. Stack parameters for cogeneration unit stack
2. The CCME NO_x emissions limit for non-peaking stationary natural gas-fired turbines with electricity output over 20 MW is 140 g/GJ

5.18 Stack Location Plot Plan

The locations of air emission discharge points for the Pierre River Mine are shown in the facilities plot plan in Section 6, Ore Processing.

5.19 Compressor Building Height

This is not applicable to the Pierre River Mine.

5.20 Natural Gas Heaters, Treaters and Boilers

One heat recovery steam generator (HRSG), which is associated with the natural gas-fired cogeneration unit, and space heaters, will be used at the Pierre River Mine. This equipment will meet applicable CCME NO_x emission requirements. Table 19-6 shows the heating specifications for winter operations.

5.21 Auxiliary or Standby Process Equipment and Other Sources

The Pierre River Mine includes a boiler associated with the asphaltene-fired cogeneration unit. Table 19-7 lists the boiler specifications for this unit.

Table 19-6: Process and Space Heater Specifications (Continuous Operation)

Source	Natural Gas-Fired Cogeneration Unit – HRSG	Space Heaters
Maximum energy input (kW)	146,000	1,172
Maximum energy output (kW) [1]	278,000	1,067
Stack height (m)	40 [2]	—
Stack diameter (m)	4.30 [2]	—
Exhaust gas temperature (ºC)	87 [2]	—
Exhaust gas velocity (m/s)	23.0 [2]	—
NO_x emissions factor (ng/J)	40 [3]	42 [4]
NO_x emissions (t/d)	1.04	0.01

Note:

1. Maximum energy output includes heat recovered from the cogeneration unit turbine exhaust.
2. Stack parameters for cogeneration unit stack.
3. CCME NO_x emission limit for boilers and heaters with energy input greater than 100 MMBTU/hr (29,288 kW) is 40 ng/j. The CCME NO_x emission limit for boilers and heaters with energy input between 10 and 100 MMBTU/hr (2,929 and 29,288 kW) is 26 ng/J.
4. NO_x emission factor based on U.S. EPA AP-42 NO_x emission factor of 100 lb/MMscf.

Table 19-7: Asphaltene Cogeneration Unit – Boiler Specifications

Source	Asphaltene Cogeneration Unit – Boiler
Maximum energy input (kW)	863,345
Maximum energy output (kW)	717,502
Stack height (m)	150
Stack diameter (m)	4.50
Exhaust gas temperature (°C)	55
Exhaust gas velocity (m/s)	20.0
NO_x emissions rate g/(kW*hr)	0.1
NO_x emissions (t/d) *	2.89

Note *: Based on 99% sulphur removal efficiency for wet limestone scrubber.

Standby equipment includes three auxiliary boilers. The boiler specifications are listed in Table 19-8. For a description of auxiliary facilities, see Section 8, Utilities and Infrastructure.

Table 19-8: Auxiliary Boiler Specifications

Source	Auxiliary Boiler	Auxiliary Boiler	Auxiliary Boiler
Maximum energy input (kW)	220,556	220,556	220,556
Maximum energy output (kW)	187,500	187,500	187,500
Stack height (m)	40	40	40
Stack diameter (m)	2.74	2.74	2.74
Exhaust gas temperature (ºC)	163	163	163
Exhaust gas velocity (m/s)	21.9	21.9	21.9
NO_x :			
• Emissions factor (ng/J)	40	40	40
• Emissions (t/d)	0.42	0.42	0.42
Note *: The CCME NO_x emissions limit for boilers and heaters with energy input greater than 100 MMBTU/hr (29,288 kW) is 40 ng/J.			

5.22 Flare Stacks

A relief and blowdown system at the Pierre River Mine will safely and effectively dispose of any hydrocarbon vapours that might accumulate or be generated during a large process upset or a shutdown of operations. This system will consist of two flares, which will accommodate loads from:

- froth treatment
- the SRU
- the TSRU

The emergency flare will be 1.4 m in diameter and a minimum of 120 m high. The smaller flare stack will be 0.5 m in diameter and 40 m high. Both will be located west of the processing plant. Under emergency conditions, the net heating value of the gas combusted will be 152.76 MJ/m^3, and the exit velocity will be 50 m/s.

5.23 Flare Pits

These are not applicable to the Pierre River Mine.

5.24 Inactive or Former Flare Pits

This is not applicable to the Pierre River Mine.

5.25 Emergency Flaring Scenarios

Flaring will be minimized for the project, such as for upset or emergency conditions, start-up and commissioning, and will comply with EUB Directive 060. A description of emergency flaring scenarios is provided in EIA Volume 3, Appendix 3-8, Air Modelling Methods.

5.26 On-Site Solid Waste Incineration

Solid waste will not be incinerated on site.

5.27 Maximum Ground-Level Concentration of SO_2, NO_2 and Other Significant Contaminants

For details of the maximum ground-level concentration of SO_2, NO_2 and other air contaminants, see Item 5.8, earlier in this section, and EIA Volume 3, Section 3.3, Air Quality Base Case and Section 3.4, Air Quality Application Case.

3(d) EUB APPROVALS

8.1 EUB Approval Date

Shell is seeking EUB approval as part of this integrated application by Q1 2010.

8.2 EUB Approval Number

Not applicable.

8.3 Comments on any Environmental Terms and Conditions of the Approval

Not applicable.

3e) ENVIRONMENTAL IMPACT ASSESSMENT REPORT

9.1 Was an EIA Required?

Yes. A letter from the Regional Environmental Manager, Northern Region, AENV, and dated March 6, 2007, pursuant to Section 44(1)(a) of the EPEA, advised Shell to prepare and submit an EIA for the Jackpine Mine Expansion and the Pierre River Mine.

9.2 Date of the EIA Report Submission and Acceptance

The EIA report submission date is the same as the one shown on the transmittal letter at the front of this Volume, and is provided as part of this integrated application.

3(f) EXISTING APPROVALS UNDER THIS ACT

10.1 Applicable Existing Approvals

There are no existing applicable approvals.

3(g) PROJECT SCHEDULE

11.1 Proposed Dates for Construction and Operations

For schedule information, see Item 5.4, earlier in this section, and Section 1, Overview.

3(h) SUBSTANCES RELEASED INTO THE ENVIRONMENT

14.1 List and Quantities of Substances Used in the Production Process

For production process substance information, see Item 5.2, earlier in this section.

14.2 Air and Water Demands

Water Demand

Water balances for the Pierre River Mine are provided in Items 5.8 and 5.9, earlier in this section, Section 9, Material and Energy Balances, and Section 10, Water Management.

Air Demand

Compressed air demands for the Pierre River Mine are provided in Items 5.8 and 5.9, earlier in this section, and Section 8.4, Auxiliary Utilities.

14.3 Source of Released Substances

For information on sources of released substances, see Item 5.8, earlier in this section.

14.4 Quantities of Released Substances

For information on quantities of released substances, see Item 5.8, earlier in this section.

14.5 Methods of Release

Stationary combustion units will release combustion by-products from their stacks. The mine fleet will emit from stacks on each piece of equipment. The mine face and external tailings disposal area will emit volatile organic compounds from their surfaces, contingent on ambient conditions.

For information on quantities of released substances, see Item 5.8, earlier in this section.

14.6 Minimization Controls Implemented

The minimization controls implemented for waste management, primarily recycling and reuse, are discussed in Section 11, Waste Management. The

14.6 Minimization Controls Implemented (cont'd)

minimization controls implemented for emissions to air are discussed in Item 5.13, earlier in this section. The minimization controls implemented for wastewater discharges and seepage, primarily close-circuiting of the development area, are also discussed in Item 5.13, earlier in this section.

For detailed information, see Item 5.13, earlier in this section, and EIA Volume 3, Section 3, Air Quality, and Section 4, Noise.

14.7 Stormwater Runoff

The water management plan requires that water coming in contact with the industrial area be recycled and used in the process. To do this, a closed-circuit industrial water system will be created and expanded to collect process-affected water within the new mining areas.

Additional information on the water management infrastructure will be provided during detailed engineering. Approval for updated plans will be obtained before construction.

Sources of industrial (process-affected) runoff water are:

- the plant site, including the ore preparation area
- the ETDA
- mine pit runoff and drainage

During operations, runoff from these sources will be collected within a closed-circuit system and used in the process.

Plant Site Runoff

Runoff from the plant site will be collected with the treated plant wastewater and sent to the process water-recycling pond. Ditches designed and built to avoid ponding will collect the on-site road drainage within the plant and ore preparation areas. Culverts will be provided at road crossings. The water will be treated in sedimentation ponds to remove oil before being mixed with the closed-circuit industrial water system for recycling.

ETDA Runoff

For tailings water and runoff from the external tailings disposal area, a significant amount of the water that is required to transport process tailings to the disposal sites will be recycled via a reclaim system. Runoff from the external surface of the tailings dyke and tailings seepage collected at the seepage pond within the perimeter ditch will be pumped into the external tailings disposal area.

Mine Pit Runoff and Drainage

Mine pit drainage will generally be collected in the closed-circuit industrial water system and recycled.

3(i) SUMMARY OF ENVIRONMENTAL MONITORING INFORMATION

17.1 Environmental Baseline Data

Environmental baseline data for the Pierre River Mine is included in Shell's application for the approval of the Jackpine Mine Expansion and Pierre River Mine Project (December 2007). The following environmental baseline reports for the Pierre River Mine are included with this application in the EIA:

- Aquatics Environmental Setting Report – Golder 2007
- Terrestrial Environmental Setting Report – Golder 2007
- Cultural Environmental Setting Report – Golder 2007
- Hydrogeology Environmental Setting Report – WorleyParsons Komex 2007

Additional baseline information included in the EIA is listed in Table 19-9.

Table 19-9: Location of Environmental Baseline Information in the EIA

Subject	Location
Air quality	Volume 3, Section 3, Appendix 3-7
Biodiversity	Volume 5, Section 7.2
Fish and aquatic habitat	Volume 4, Section 6.6, 6.7,
Forestry	Volume 5, Section 7.2
Historical resources	Volume 5, Section 8.6
Hydrogeology	Volume 4, Section 6.3
Noise	Volume 3, Section 4, Appendix 3-10
Resource use	Volume 5, Section 8.4
Soil and terrain	Volume 5, Section 7.2
Surface water hydrology	Volume 4, Section 6.4
Terrestrial resources and wetlands	Volume 5, Section 7.2
Traditional land use	Volume 5, Section 8.3
Water quality	Volume 4A, Section 6.5
Wildlife	Volume 5, Section 7.2

17.2 Baseline Hydrogeological Characteristics and Groundwater Monitoring Data

The baseline hydrogeological characteristics for the Pierre River Mine are discussed in:

- Hydrogeology Environmental Setting Report for Jackpine Mine Expansion and Pierre River Mine Project – WorleyParsons Komex 2007
- EIA, Volume 4, Aquatic Resources, Section 6.3.3, Hydrogeology

3(k) JUSTIFICATION FOR THE RELEASE OF SUBSTANCES TO THE ENVIRONMENT

23.1 Process and Environmental Control Technologies and Management Practices

(a) The evaluation and identification of alternative processes and technologies are discussed in Section 13, Alternatives Considered.

(b) Input substitution has occurred in several ways, as shown in Table 19-10.

Table 19-10: Input Material Comparison

Conventional Practice	Pierre River Mine	Environmental Significance
Nonparaffinic solvent	Paraffinic solvent	Lower VOCs and lower solid content in bitumen
Import electricity	Cogeneration facility on site	Lower CO_2 emissions, use of waste heat and elimination of line losses
Hot water extraction process	Warm water extraction process	Savings in energy use
Natural gas combustion	Asphaltene combustion	Reduced hydrocarbon and fines to environment and increased air emissions
Conventional coarse and fine tailings	Engineered tailings using thickeners	Reduced volume of fine tailings and savings on energy use

(c) Industry standards and guidelines will be used in addressing the release of substances to the environment in the following areas:

- air emissions
- water effluent
- solid waste

For further information, see Section 8, Utilities and Infrastructure, and EIA Volume 3, Section 3, Air Quality and Noise.

Air Emissions

For a list of the mitigation measures and controls to meet the air quality standards and guidelines, see Item 5.13, earlier in this section.

Water Effluent

The mitigation measures and controls to meet the water quality standards and guidelines are listed in Item 5.13, earlier in this section. For further information, see Section 10, Water Management, and EIA Volume 4, Section 6, Aquatic Resources.

Solid Waste

To meet standards and guidelines for solid waste, activities will be supported by waste management facilities at the Pierre River Mine. This will allow for constructing and operating:

- an on-site Class III landfill for the disposal of inert solid waste

- a hazardous waste storage area

The on-site registered landfill will meet regulatory requirements and, where practical:

- recyclable solid waste will be diverted from the landfill
- empty plastic oil pails and jugs collected around the site will be recycled through the Alberta Used Oil Management Association
- paper products and some beverage containers will be recycled
- any reusable wood or pallets will also be diverted from the landfill and used, where applicable

For further information, see Section 11, Waste Management.

(d) Currently, mining and bitumen extraction projects that have received similar regulatory approval include the:

- Shell Canada Limited Muskeg River Mine
- Shell Canada Limited Jackpine Mine – Phase 1
- Albian Sands Muskeg River Mine Expansion
- Syncrude Canada Ltd Aurora Mine
- Imperial Oil Resources Limited Kearl Oil Sands Project
- Suncor Energy Inc. Millennium Project
- Suncor Energy Inc. Voyageur Project
- Canadian Natural Resources Limited Horizon Project

(e) Potential environmental impacts are summarized in Section 17, EIA Summary, and EIA Volume 3, Section 2, Summary of the EIA and SEIA.

(f) No unique situations are applicable to this application.

(g) Ambient guidelines and standards were considered when choosing process technology and environmental control systems to be used for the Pierre River Mine. For further information, see:

- Section 8, Utilities and Infrastructure
- EIA Volume 3, Section 3, Air Quality
- EIA Volume 3, Section 4, Noise
- EIA Volume 4, Section 6, Aquatic Resources

23.2 Other Alternatives Considered

In preparation for the integrated application, the alternatives for different components of the project were extensively reviewed, including the environmental considerations. For further information, see Section 1, Overview, and Section 13, Alternatives Considered.

3(l) WASTE MINIMIZATION MEASURES AND DISPOSITION OF WASTE

26.1 Disposition of Waste Streams

The disposition of waste streams is discussed in Section 11, Waste Management.

26.2 Waste Minimization Measures

The Pierre River Mine will implement a waste minimization program with the following principles:

- minimize the quantities of waste generated by focusing on:
  - reducing waste at the source
  - improving inventory control and purchasing criteria
  - and replacing a material with one that produces less waste and a more benign waste, when there is suitable opportunity
- recycle spent products or materials into useable materials at the project site or with off-site third-party recyclers and reclaimers, to the extent practicable
- provide employee awareness and monitoring programs that include waste minimization and recycling practices

For detailed information, see Section 11, Waste Management.

26.3 Liquid Effluent and Process Wastewater or Air Emissions Treatment Facilities

For liquid effluent, see Item 5.8, earlier in this section. For air emissions, see Item 5.8 and Item 22.1, earlier in this section. Information on liquid effluent and process water treatment facilities is provided in Section 8, Utilities and Infrastructure, Section 10, Water Management and Section 11, Waste Management.

3(m) SURFACE DISTURBANCE

29.1 Extent and Nature of Surface Disturbance

The extent and nature of surface disturbance from the activities associated with the Pierre River Mine are discussed in Section 5, Mining, and EIA Volume 5, Appendix 5-2, Closure and C&R Plan.

3(n) EMERGENCY RESPONSE PLANS

32.1 Confirmation that an Emergency Response Plan Has Been Filed

Emergency preparedness and response is discussed in Section 12, HSE – SD Management.

3(o) SUBSTANCE RELEASE CONTINGENCY PLANS

33.1 Environmental Contingency Plans to Deal with Abnormal Occurrences

Contingency planning is discussed in Section 12, HSE – SD Management.

3(p) CONSERVATION AND RECLAMATION PLAN

34.1 Preconstruction Site and Soil Assessments

For the Conservation and Reclamation Plan, see Section 20.

34.2 Conservation and Reclamation Plan

For the Conservation and Reclamation Plan, see Section 20.

3(q) PUBLIC CONSULTATION

37.1 Describe the Public Involvement Process

Shell Canada Limited's public involvement process is discussed in Section 1, Overview and Section 15, Public Consultation.

37.2 Target Audiences and Environmental Concerns Identified

The target audiences and environmental concerns identified and addressed are discussed in Section 15, Public Consultation, and EIA Volume 5, Section 8.7, Socio-Economic Assessment

3(r) OTHER REGULATORY INFORMATION SUBMITTED IN SUPPORT OF THE APPLICATION

40.1 Other Information under EPEA Submitted in Support of this Application

For details of other approvals being sought under the EPEA, see Section 1.4, Regulatory Approvals.

**APPLICATION FOR APPROVAL OF THE
PIERRE RIVER MINE PROJECT
VOLUME 2: PROJECT DESCRIPTION**

INTRODUCTION

PURPOSE OF THIS PLAN

This Conservation and Reclamation (C&R) Plan outlines the vision, goals, approach and preliminary plans for reclaiming areas disturbed throughout the Pierre River Mine area within the context of the 10-year *Environmental Protection and Enhancement Act* (EPEA) approval period. As a result, the focus of this C&R plan is on the first 10 years of the Pierre River Mine development. However, the information is given within the context of the end of mine closure plan. The detailed Closure, Conservation and Reclamation Plan for the Pierre River Mine area, as presented in EIA Volume 5, more fully describes conservation and reclamation beyond the initial 10-year EPEA approval period focusing on the final closure landscape.

Much of the information regarding specific reclamation activities and goals has not changed from the original Muskeg River Mine and Jackpine Mine – Phase 1 applications and subsequent updates. Specific conservation and reclamation activities described within the draft EPEA approval conditions (No. 20809-01-00) for the Muskeg River Mine Expansion have been used as a framework for this C&R plan.

SUMMARY OF AREA DEVELOPMENT

The Pierre River Mine area development plan includes:

- a total disturbance area of 10,403 ha, located in Leases 9, 17, 351 and 309 (see Figure 20-1)
- a soil and vegetation disturbance of 10,403 ha (see Table 20-1)
- a 22-year operating life, ending in 2039

The mining area will be developed in phases, which will allow progressive reclamation practices to be used.

The development components covered in the C&R Plan include:

- a plant site
- a mine pit

SUMMARY OF AREA DEVELOPMENT (cont'd)

- overburden disposal areas
- an external tailings disposal area (ETDA)
- reclamation material stockpiles (RMS)
- main access and utility corridors connecting the plant site with external services, such as roads, natural gas, electrical power and the product pipeline
- water control and diversion structures
- construction of a water intake and a bridge over the Athabasca River
- a compensation lake

Table 20-1: Soil and Vegetation Disturbances for the Pierre River Mine Area

Project Component	Pierre River Mining Area (ha)	Total Soil and Vegetation Disturbance Area (ha)
External tailings disposal area	1,575	1,575
Overburden disposal areas	134	134
Mine pit	4,332	4,332
Plant site	470	470
Reclamation material stockpiles	195	195
Roads, drainage and utility corridors, setbacks	2,457	2,457
Compensation lake	425	425
Water control structures	816	816
Total disturbance	**10,403**	**10,403**
Existing disturbances[1]	746	746
Net new disturbance[2]	9,657	9,657

Note: Totals might appear incorrect because of rounding.

1. Existing disturbances are the disturbances that have already occurred in the project area before the Pierre River Mine development. These activities are related primarily to previous exploration activities.
2. Net new disturbance is the total disturbance minus the existing disturbance.

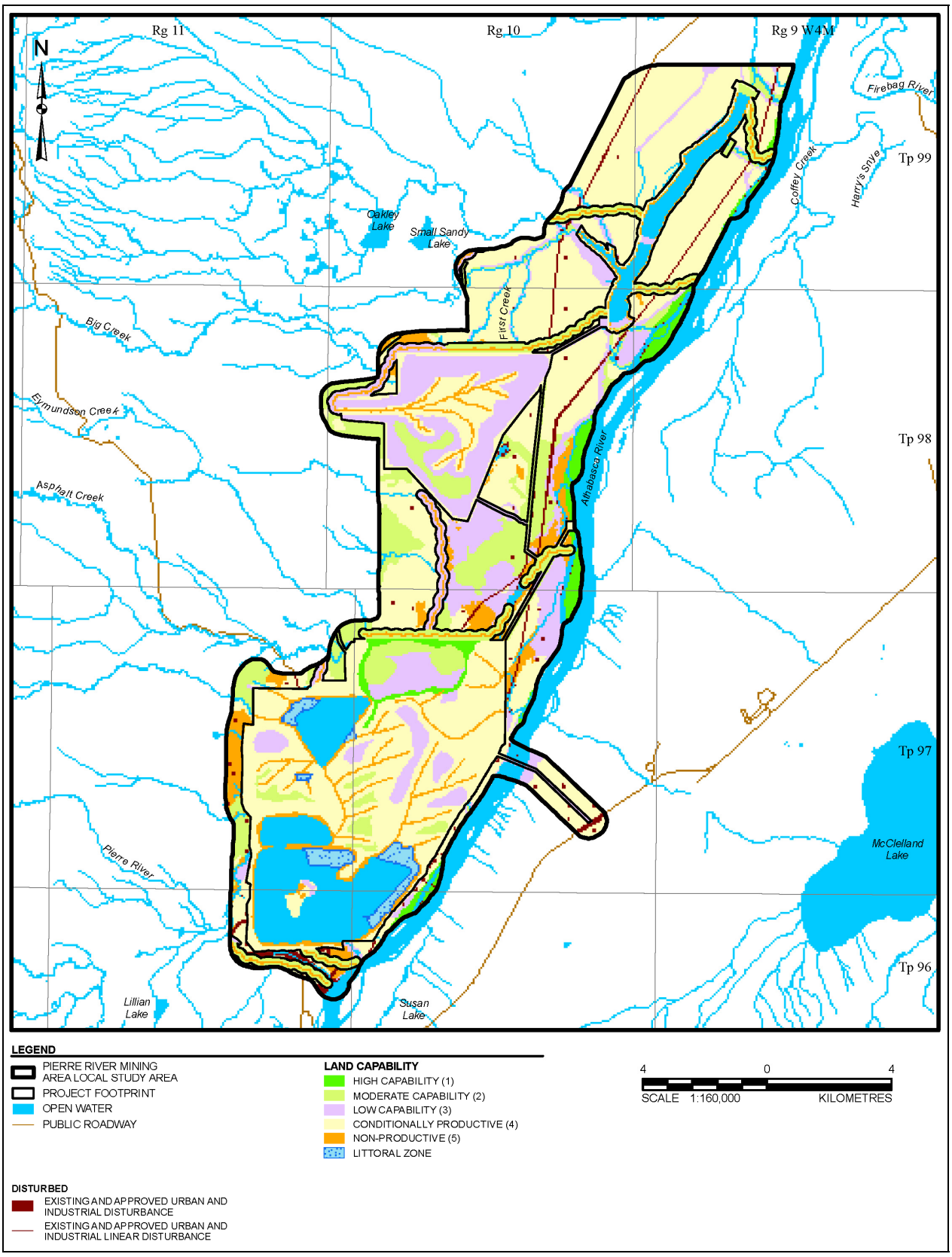


Figure 20-1: Closure Land Capability in the Pierre River Mine Area

SOIL SALVAGE

Strategy

The C&R activities for the first 10 years of activity on the Pierre River Mine will be limited to soil salvage and stockpiling. Therefore, the soil salvage plan and reclamation material balance for the Pierre River Mine are the focus of this C&R plan.

Soil salvage and reconstruction strategies have been adapted from those in the draft EPEA approval conditions (No. 20809-01-00) for the Muskeg River Mine Expansion, to reflect the unique site conditions in the development area. Definitions of soil salvage and reconstruction terms have been taken directly from the draft EPEA approval conditions (No. 20809-01-00) for the Muskeg River Mine Expansion, and are presented in Table 20-2. The Muskeg River Mine Expansion approval is based on the land returning to equivalent land capability, as documented in L. Leskiw's *Land Capability Classification for Forest Ecosystems in the Oil Sands Region*, 2006, using reclamation coversoil consisting of a combination of available soil types.

Reclamation soils will be directly placed, when possible, to:

- avoid double handling
- promote natural regeneration
- help to re-establish biodiversity

Upland Surface Soils

All upland surface soils will be salvaged from disturbed areas according to the following depth criteria, as defined in the *Field Guide to Ecosites of Northern Alberta*, 1996, J.D. Beckingham and J.H. Archibald:

- to a maximum average depth of 0.15 m from all land to be disturbed, where the ecosite classification is a or b

- to a maximum average depth of 0.3 m from all land to be disturbed, where the ecosite classification is other than a or b

Criteria used to determine the suitability of salvageable coversoil are provided in Alberta Agriculture's *Soil Criteria Relative to Disturbance and Reclamation*, 1987.

Table 20-2: Definition of Soil Terms Used in the Soil Salvage and Replacement Plan

Term	Definition
soil	Naturally occurring, unconsolidated mineral or organic material at least 10 cm thick that occurs at the earth's surface and is capable of supporting plant growth.
mineral soil	A, B and C horizons and underlying parent material.
organic horizon	Surface soil horizon in organic soils containing more than 17% organic carbon by weight.
litter-fibric-humic (LFH)	Forest floor that accumulates on the mineral soil surface under forest vegetation, and which includes dead vegetation and organic matter, including litter and unincorporated humus.
overburden	Material below the soil profile and above the bituminous sand.
upland soil	Mineral soil developed on mineral parent material under forests, in locations with imperfect drainage or drier, typically including LFH and A, B and C horizons.
upland surface soil	A stratum salvaged from an upland soil that includes the LFH, A horizon and in some cases part of, or the entire, B horizon.
subsoil	A stratum that includes one or more of the following: • the portion of the B horizon left after salvage of upland surface soil • the C horizon of an upland soil • underlying parent material at an upland location that is rated good, fair or poor • mineral material below an organic layer at a location other than upland, that is rated good, fair or poor
peat–mineral mixture	A mixture of an organic horizon and the underlying mineral soil, or an organic horizon and mineral soil from another source, where the mineral soil in both cases is rated good, fair or poor.
coversoil	Any peat–mineral mixture, organic horizon or upland surface soil used as a surface reclamation material.

Subsoil

To meet reclamation soil volumes, upland subsoil that is rated as good and fair will be salvaged first from any land that will be disturbed. Where insufficient good or fair upland subsoil exists, poor upland subsoil might be salvaged, along with good, fair or poor subsoil, from locations other than uplands. Criteria used to determine the suitability of subsoil for reclamation are provided in Alberta Agriculture's *Soil Criteria Relative to Disturbance and Reclamation*, 1987.

Peat–Mineral Mix

Peat–mineral mix will be salvaged from mine pit disturbance areas to meet reclamation material balance requirements when there is insufficient upland surface soil to meet reclamation objectives, i.e., equivalent land capability class, and for those reclamation ecosite types requiring peat-mineral soils (see EIA Volume 5). Peat–mineral mix will be preferentially salvaged from wetlands ecosite types where there are finer-textured underlying mineral soils.

Stockpiling

To limit mixing, reclamation material will be stockpiled and separated as follows:

- upland surface soil from ecosite types a and b
- upland surface soil of ecosite types other than a and b
- good to fair quality subsoils
- poor quality subsoils
- peat–mineral mixture

Within the proposed 10-year EPEA approval period (2010 to 2019), soil salvage will not likely begin until 2017. From 2017 to 2019, soil will be stockpiled in the Pierre River Mine reclamation material stockpile (RMS) area.

SOIL SALVAGE PLAN

Shell plans to salvage all upland surface soils in the mining areas and the plant site, and enough subsoil and peat–mineral mixture to meet reclamation soil requirements for closure. Table 20-3 shows the area and volume of available upland surface soil, upland subsoil and peat–mineral mixture underlying various Pierre River Mine features.

Table 20-3: Available Salvaged Soil Volume Estimates for the Pierre River Mine Area

Mine Feature	Area (ha)	Upland Surface Soil Volumes (1,000 m^3)	Upland Subsoil Volumes (1,000 m^3)	Peat–Mineral Volumes (1,000 m^3)
External tailings disposal area	1,575	1,744	6,630	13,644
Mining areas	5,148	9,841	35,810	16,736
Overburden disposal areas	134	275	885	453
Plant site	470	208	949	5,587
Reclamation material stockpiles	195	388	1,393	392
Roads, utility corridors and other features outside the mine areas	2,882	4,503	17,500	12,582
Total	**10,403**	**16,958**	**63,166**	**49,394**
Note: Totals might appear incorrect because of rounding.				

Subsoil will be salvaged only from under the mining areas, as the volume of subsoil required for reclamation is substantially less than the volume available in the development area.

Available reclamation material volumes were estimated based on the mine plan. Soil volumes were estimated by calculating an average material depth for each soil series. The average depth was then multiplied by the area of each soil series throughout the development area, to obtain the total volume.

SOIL SALVAGE PLAN (cont'd)

Peat–mineral mix volumes available within the mining areas of the Pierre River Mine are estimated to provide 16,736,000 m^3 of reclamation soil salvage. This is estimated to be in excess of the volume required for reclamation, as detailed in EIA Volume 5. Therefore, the peat–mineral mix will not be salvaged from other disturbance types in the development area.

RECLAMATION MATERIAL BALANCE

Soil salvage, placement and stockpiling balances for the Pierre River Mine are presented in:

- Table 20-4, for upland surface soil and subsoil
- Table 20-5, for peat–mineral mix

These reclamation material balances exceed the requirements stipulated in the Muskeg River Mine Expansion approval and in the *Land Capability Classification for Forest Ecosystems in the Oil Sands Region*, 2006, L. Leskiw.

The locations of upland soil and peat–mineral soil types for salvage within the Pierre River Mine development area are described in the Soil and Terrain Environmental Setting for the Jackpine Mine Expansion and Pierre River Mine Project (Section 2 of the Environmental Setting Reports).

As previously stated, all upland surface soil will be salvaged, and enough upland subsoil and peat–mineral mix will be salvaged to meet reclamation soil volume requirements. More than twice the required reclamation volume of peat–mineral mix is available within the mining area footprints alone. Therefore, salvage operations have been designed to minimize the length of time that peat–mineral mix is stockpiled before being used in reclamation activities. Based on the current mine plan, and considering preferential use of upland surface soil and subsoil for reclamation activities (except for those ecosites requiring peat–mineral mix as a reclamation soil prescription), it is expected that peat–mineral mix stockpiling will begin at least seven years after the start of mine operations.

Table 20-4: Upland Surface Soil and Subsoil Reclamation Material Balance

Year	Annual Salvage (m^3)	Annual Placement (m^3)	Stockpile Variation (m^3)	Stockpile Balance (m^3)
2010	0	0	0	0
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	0
2017	322,651	0	322,651	322,651
2018	1,139,025	0	1,139,025	1,461,676
2019	1,712,034	0	1,712,034	3,173,710
2029	418,402	0	418,402	3,592,112
2039	27,234,940	5,433,741	21,801,199	25,393,310
Closure	0[1]	25,393,310[1]	N/A[2]	N/A[2]

Note: Totals might appear incorrect because of rounding.

1. The increase in annual placement and subsequent stockpile variation in 2039 and at closure reflects the increased pace of reclamation activity from 2039 onwards at the Pierre River Mine. The information between 2019 and 2039 and from 2039 to closure reflects the emphasis on providing detailed information for the proposed 10-year *Environmental Protection and Enhancement Act* (EPEA) approval period and at closure, and therefore presents predicted cumulative salvage and placement volumes.
2. As all stockpiles are expected to be used in reclamation activities, these categories are not applicable.

Table 20-5: Peat–Mineral Reclamation Material Balance

Year	Annual Salvage (m^3)	Annual Placement (m^3)	Stockpile Variation (m^3)	Stockpile Balance (m^3)
2010	0	0	0	0
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	0
2017	505,424	0	505,424	505,424
2018	261,157	0	261,157	766,581
2019	303,710	0	303,710	1,070,291
2029	8,262,905	0	8,262,905	9,333,196
2039	0	69,487	-69,487	9,263,710
Closure	0[1]	9,263,710[1]	N/A[2]	N/A[2]

Note: Totals might appear incorrect because of rounding.

1. The increase in annual placement and subsequent stockpile variation in 2039 and at closure reflects the increased pace of reclamation activity from 2039 onwards at the Pierre River Mine. The information between 2019 and 2039 and from 2039 to closure reflects the emphasis on providing detailed information for the proposed 10-year *Environmental Protection and Enhancement Act* (EPEA) approval period and at closure, and therefore presents predicted cumulative salvage and placement volumes.
2. As all stockpiles are expected to be used in reclamation activities, these categories are not applicable.

RECLAMATION GOALS AND PRINCIPLES

Shell's reclamation goal is to achieve maintenance-free, self-sustaining ecosystems with a capability equivalent to predevelopment conditions. This goal is shared with other oil sands mining operators, such as CNRL (Horizon Oil Sands Project), Suncor (Voyageur South Project) and Imperial Oil (Kearl Oil Sands Project).

CLOSURE PLANNING PROCESS

The closure planning process considered the following:

- Mine plans and closure plans are interlinked. Changes to mine plans necessitate changes to associated closure plans.
- Integrated closure drainage plans and closure plans are interlinked. Changes to closure drainage plans necessitate changes to associated closure plans.
- The probability of changes to both the Pierre River Mine area plans and the closure plans increases over time. For example, changes over five years are expected to be less than those over 20 years.
- Landforms will be designed according to the Cumulative Environmental Management Association Reclamation Working Group's 2004 *Landscape Design Checklist*.
- Ongoing research programs are expected to affect the long-term performance of landforms, the feasibility of developing trafficable tailings landforms (e.g. non-segregating tailings), the long-term performance of vegetation communities and the capability of returning landscape biodiversity. These research programs might lead to changes in technologies and performance criteria.
- Uncertainties in landscape performance and technology will be dealt with using the principles of adaptive management, and knowledge gaps will be filled through research programs.
- The closure plan is conceptual because of the evolutionary nature of both mine technology development and reclamation planning.

DETAILED RECLAMATION PLANNING

The detailed reclamation planning process is designed considering the following:

- Reclamation practices detailed in the draft EPEA Approval No. 20809-01-00 conditions for the Muskeg River Mine Expansion will be used as the basis for soil salvage, reconstruction and revegetation.
- The goal of equivalent capability will be met by using methods outlined in the *Land Capability Classification for Forest Ecosystems in the Oil Sands Region*.
- Reconstructed soil performance will mimic natural soils over time.
- Wetlands reconstruction practices will follow the 2007 draft *Guideline for Wetland Establishment on Reclaimed Oil Sands Leases*, as amended in the final version to be released.
- Revegetation practices will follow the *Guidelines for Reclamation of Terrestrial Vegetation in the Oil Sands Region*, 1998, Oil Sands Vegetation Reclamation Committee (OSVRC).
- Species identified in the OSVRC 1998 guidelines will be available for use.
- The target vegetation communities identified in the C&R Plan are conceptual, and it is not currently possible to predict ecosystem succession over time.

END LAND USE AND FINAL CERTIFICATION

The end land use and final certification process considers that:

- Shell has also incorporated into the closure plan the resources and values identified in the *Fort McMurray – Athabasca Oil Sands Subregional Integrated Resource Plan,* 2002, Alberta Sustainable Resource Development
- the target ecosystems and vegetation communities identified in the closure plan will allow multiple uses. For example, areas designated for commercial forest use could also provide wildlife, recreation and traditional land uses.
- end land use options available will be constrained by the type of landforms to be constructed
- final end land use decisions will depend on input from the regulators and local stakeholders

ACHIEVING EQUIVALENT LAND CAPABILITY

Information in the land reclamation and closure planning sections is provided to indicate the closure conditions considered in the context of the 10-year EPEA approval period. Further details of sections outlined here are provided in EIA Volume 5.

The reclamation requirement is to return the approved development area to equivalent pre-disturbance land capability within the reclaimed area. The new closure plan will ensure that equivalent capability is maintained for the Pierre River Mine area.

Table 20-6 summarizes changes in each land capability class in the development area. Soils classified as suitable for forestry, i.e., Classes 2 and 3, represent an area of 3,273 ha (31%) of a total area of 10,403 ha in the pre-development conditions. Classes 1 and 2 soils (high to moderately productive) are predicted to increase at closure, and Classes 3 to 5 soils (low, conditionally productive and non-productive) are predicted to decrease.

Table 20-6: Changes in Predicted Forestry Capability Class After Reclamation of the Pierre River Mine Development Area

Forestry Capability Class	Pre-Development		Closure		Net Change	
	Area (ha)	Percent	Area (ha)	Percent	Area (ha)	Percent
1: High	0	0	158	2	158	2
2: Moderate	546	5	1,361	13	815	8
3: Low	2,707	26	1,973	19	-734	-7
4: Conditionally productive	3,697	36	3,654	35	-43	-1
5: Non-productive	3,326	32	1,020	10	-2,306	-22
Littoral zone	0	0	254	2	254	2
Water	65	<1	1,920	18	1,856	18
Undisturbed	62	1	62	1	0	0
Total	**10,403**	**100**	**10,403**	**100**	**0**	**0**

Note: Totals might appear incorrect because of rounding.

The average land capability for forestry in the Pierre River Mine disturbance area is predicted to be equivalent to pre-disturbance levels after reclamation. The reclaimed area is predicted to include a diversity of upland and lowland habitats. Detailed land capability classifications for the development area under pre-development and closure conditions are provided in EIA Volume 5.

Soil and Terrain

The following changes to soils within the development area are predicted:

- 8,232 ha (79% of the development area) of natural soil types will be converted to reclamation soil types

Soil and Terrain (cont'd)

- mineral soil will decrease by 265 ha (2% of the development area) at closure
- organic soils will decrease by 1,844 ha (18% of the development area)

Table 20-7 summarizes the predicted changes in soil types.

A summary of changes to terrain, specifically changes in slope and moisture regimes, is provided in EIA Volume 5.

Table 20-7: Summary of Predicted Changes to Soil Types in the Pierre River Mine Area

Soil type	Pre-Development		Closure		Net Change	
	Area (ha)	Percent of Development Area	Area (ha)	Percent of Development Area	Area (ha)	Percent of Development Area
Mineral	6,370	61	6,105	59	-265	-2
Organic	3,906	38	2,062	20	-1,844	-18
Subtotal (soil units)	10,276	99	8,167	79	-2,109	-20
Littoral zone	0	0	254	2	254	2
Water	65	<1	1,920	18	1,855	18
Undisturbed	62	1	62	1	0	0
Subtotal (non-soil units)	127	1	2,236	21	2,109	20
Total	**10,403**	**100**	**10,403**	**100**	**0**	**0**
Note: Totals might appear incorrect because of rounding.						

CLOSURE DRAINAGE PLAN

Development of the Pierre River Mine requires diversion of natural watercourses during operations and at closure. These drainage features are described in detail in EIA Volume 2. Regarding closure planning, post-mining landforms and the nature of closure drainage systems direct how the Pierre River Mine can be closed. Specifically, the Pierre River Mine will encompass two distinct areas at closure:

- a northern drainage area, i.e., reclaimed ETDA
- a southern drainage area, i.e., reclaimed mining area

Figure 20-2 shows these areas and their design features.

At closure, the northern drainage area will consist entirely of tailings sand. The surface water will be conveyed through a series of swales to a central drainage channel excavated into the northern portion of the ETDA. The drainage channel will exit the ETDA on the west side and flow along the northern edge of the ETDA before discharging into the treatment lake (formerly the raw water storage facility) during operations. This treatment lake will serve at closure to treat runoff and seepage from the ETDA, rather than act as a source of raw water.

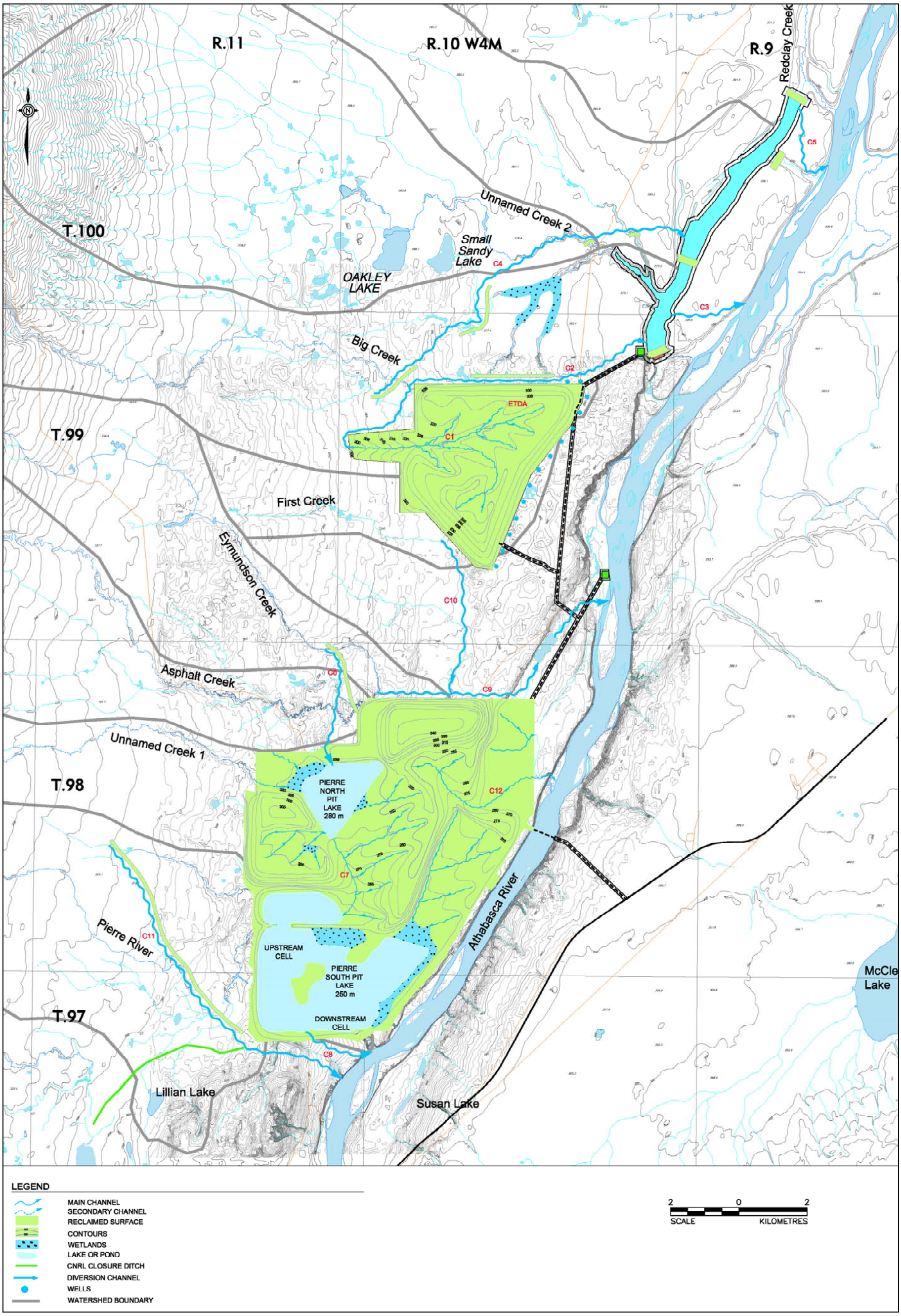


Figure 20-2: Closure Drainage Plan for the Pierre River Mine Area

CLOSURE DRAINAGE PLAN (cont'd)

The water will be discharged from the treatment lake to the Athabasca River once water quality discharge criteria are achieved. Big Creek and several smaller unnamed creeks will be diverted north of the ETDA and discharged into the Redclay Compensation Lake (for a further description of the Redclay Compensation Lake, see EIA Volume 4). The Redclay Compensation Lake will flow into the Athabasca River.

Eymundson Creek, Asphalt Creek and an unnamed creek will flow into the Pierre North Pit Lake within the southern drainage area. The Pierre River and several small channels will be diverted south around the mining area and will discharge directly into the Athabasca River. The surface runoff from within the mining area will be collected and routed through a drainage system consisting of small drainage channels, wetlands and pit lakes.

The Pierre North Pit Lake will discharge into the Pierre South Pit Lake via a constructed channel. Several small drainage channels will direct runoff from the adjacent overburden-capped tailings cells to the Pierre North Pit Lake or the channel connecting the two pit lakes. Runoff from the eastern in-pit tailings cell will flow directly into the Pierre South Pit Lake. The Pierre South Pit Lake will be connected to the Athabasca River.

The proposed drainage systems include such natural features as floodplains and wetlands, and end-pit lakes for:

- flood flow attenuation
- bioremediation of runoff
- seepage from reclaimed areas

Littoral zones with shallow wetlands will occur along the shorelines of the pit lakes. Each littoral zone will occupy 10 to 30% of the total surface area of each pit lake.

The closure drainage plan for the Pierre River Mine area was developed to accomplish the objectives of long-term self-sustainability and minimal aquatic impacts on receiving streams. The drainage routes were selected and designed to:

- maximize long-term self-sustainability
- minimize the changes in flow in the surrounding creeks and rivers
- allow for fish migration

Details of the closure drainage plan and drainage systems are provided in EIA Volume 4B.

EROSION CONTROL

Slope erosion along river valleys is a natural process and will likely occur on all reclaimed structures. Reclamation drainage courses will alter over time as natural

erosion occurs. Every reasonable effort will be made to predict and accommodate such shifts, using:

- erosion-resistant overburden to backfill critical areas, such as drainage outlets between ponds
- the pit lake inlet, outlet and designated shorelines

Erosion control will be incorporated in drainage channels, including armouring with riprap, where applicable. Most drainage channels will not require armouring because they will incorporate natural channel design features, such as low channel gradients, meanders and floodplains. These natural features can accommodate large flow events without a system failure.

Erosion rates will be minimized by revegetating disturbed areas as soon as they become available for revegetation. Tailings disposal area slopes will vary, but may be as shallow as 12:1 to ensure geotechnical stability and to minimize erosion. After construction, containment berms and road cuts will be temporarily revegetated for erosion control.

SOIL RECONSTRUCTION

Soil Placement

Reclamation material, consisting of a combination of coversoil and subsoil, will be placed at an average depth of 0.5 m on all reclamation areas. Where the overburden beneath the coversoil is rated as good or fair, it will be considered as part of the total depth requirement of 0.5 m. Where upland surface soil is used, it will be replaced at a minimum depth of 5 cm.

Soil Prescriptions

The following prescriptions will be used for peat–mineral mixture:

- when peat–mineral mixture is used as coversoil immediately over subsoil or overburden containing 20% or more clay, it will be placed at an average minimum depth of 0.3 m
- when peat–mineral mixture is used as coversoil immediately over subsoil or overburden containing less than 20% clay, it will be placed according to the following targeted land capability classes:
    - Class 1 – average minimum 0.5 m
    - Class 2 – average minimum 0.5 m
    - Class 3 – average minimum 0.4 m
    - Class 4 – average minimum 0.3 m
    - Class 5 – average minimum 0.3 m

Soil Capability

Determining land capability class based on the above prescriptions depends on:

- the quality of coversoil and subsoil or overburden used at each site
- the slope, aspect and moisture regime provided by the closure landform

The reconstructed soil will have the following specifications:

- able to retain moisture
- able to supply nutrients
- able to support an erosion-resistant vegetative cover

The productive capabilities of natural soil types in the area will be used as benchmarks for the main post-mining landforms. The physical and chemical parameters of the natural soils will be compared to the reconstructed soils, to assess the effectiveness of reconstructed soils in meeting both the above specifications and Shell's reclamation goals.

The closure plan assumes that the following landforms will be capped with at least 1 m of tailings sand, overburden or other appropriate materials, before reclamation soils are applied, according to the appropriate prescriptions:

- areas with impervious surface materials, such as lean oil sands or rock
- areas used to store reject from the oil sands conditioning and transport system
- in-pit tailings disposal areas, i.e., areas containing non-segregated tailings
- areas with exposed Clearwater Formation overburden
- the plant site

The Pierre River Mine area does not contain Clearwater Formation materials with high sodium adsorption ratio values. However, soil samples will be analyzed during construction to confirm the quality of the overburden materials at the surface. Materials with high saline and sodic concentrations are less desirable for reclamation landform construction. No materials with a sodium adsorption ratio greater than 10 will be placed within 1 m of the surface.

REVEGETATION

Guidelines and Practices

Shell will continue to follow established revegetation practices as approved for the Muskeg River Mine Expansion. Current practices reflect the recommendations provided in OSVRC's 1998 *Guidelines for Reclamation of Terrestrial Vegetation in the Alberta Oil Sands Region*. These guidelines specify

planting prescriptions for target ecosite phases in the Central Mixedwood Subregion of Alberta. As most of the development area falls within the newly designated Athabasca Plain Subregion, planting prescriptions were adapted according to the target ecosite phases outlined in the *Field Guide to Ecosites of Northern Alberta*. In addition, the objectives for revegetating the Pierre River Mine area will incorporate the issues addressed in Alberta Sustainable Resource Development's 2002 *Fort McMurray–Athabasca Oil Sands Subregional Integrated Resource Plan*, concerning:

- wildlife
- erosion
- floodplains
- recreation and tourism
- ecological resource management

Objectives

The revegetation objective is to provide a diverse vegetation community on the reclaimed landscape that will:

- integrate with surrounding developed and undeveloped areas
- achieve land capability classes equivalent to those present in pre-development conditions

The primary objectives of Shell's revegetation program are to:

- provide an erosion-resistant plant cover on tailings dyke slopes and overburden disposal area slopes
- provide a diverse range of plant species at the start of reclamation to increase the potential of reclaimed sites to evolve to biodiversity levels consistent with the pre-development state
- establish self-sustaining, viable plant communities during reclamation
- provide timber, wildlife habitat and traditional end land uses, consistent with traditional resource use and traditional ecological knowledge

Planting Prescriptions

Planting prescriptions based on target ecosite phases are determined by the predicted soil moisture and nutrient regimes, which depend on the type of:

- reclamation materials
- landform structures, such as dykes, overburden disposal areas, tailings sand or non-segregating tailings cells
- slope conditions and aspect
- soil capability class

Planting Prescriptions (cont'd)

- drainage conditions
- ecosystem succession

Vegetation communities that will successfully establish and develop under various combinations of these factors have been the subject of research and monitoring programs conducted over the previous 25 years in the oil sands region. These communities are expected to develop into biodiverse, mature plant community stages containing boreal forest species that are suitable for traditional land uses, wildlife use, recreational and other end land uses.

Although planting prescriptions for specific target ecosite phases will be used on various landscapes, natural processes will ultimately determine the progression and eventual vegetation community on the reclaimed landscape. Revegetation will be augmented by natural succession, thereby providing a framework for the revegetated areas to evolve into ecosystems similar to those found in the region.

Direct placement of suitable material on reclamation areas enhances site revegetation. This is because dormant, in situ, native seed and viable root fragments are transferred with the soil amendment. Spreading the material on a reclamation area in early spring usually results in various native forbs, wildflowers, grasses and woody-stemmed species emerging over the late spring and summer. Direct placement will be implemented wherever practical.

Establishing woody plants in reclamation areas is a fundamental part of the reclamation process. Species selection and proportion in the supplemental planting mixture are based on:

- woody-stemmed species common to the target ecosites
- existing field conditions
- vegetation type or types desired for development on the site, based on end land use objectives and landscape terrain features
- the expected growth of woody-stemmed species from seeds and root fragments in the reclamation material layer

Revegetation Schedule

Table 20-8 outlines the revegetation schedule.

Revegetation Plan

The planting prescriptions for target ecosite phases (see Table 20-9) and shrubland (see Table 20-10) consider variations in slope, aspect, drainage, reclamation material, depth and composition to start the process of reaching a target ecosite (see *Guidelines for Reclamation of Terrestrial Vegetation in the Oil Sands Region*, 1998, OSVRC)

Table 20-8: Revegetation Schedule for the Pierre River Mining Area

Year	Area Description	Area (ha)
Pre-2010	No revegetation	0
2010	No revegetation	0
2011	No revegetation	0
2012	No revegetation	0
2013	No revegetation	0
2014	No revegetation	0
2015	No revegetation	0
2016	No revegetation	0
2017	No revegetation	0
2018	No revegetation	0
2019	No revegetation	0
2029	No revegetation	0
2039	External tailings disposal area dyke wall, north part of the north overburden disposal area, Cell 3 in-pit disposal area	1,133
Closure	All remaining areas, except for closure end-pit lakes	8,579
	Total	**9,712**
Note: Total might appear incorrect because of rounding.		

Shrubland mixtures are prescribed for two specific areas within the development area:

- at the margins of drainage channels and wetlands shown in the closure drainage plan
- the banks of pit lakes

Figure 20-3 shows reclamation ecosites prescribed for the Pierre River Mine area.

The assignment of planting prescriptions considers that:

- establishing an ecosystem starts with the appropriate choice of landscape position, moisture regime and nutrient regime. If soil chemistry is appropriate, trees and shrubs for the target ecosystem might then be established.
- the existing oil sands planting prescription convention uses 1,800 trees/ha and 300 shrubs/ha, with a maximum of four species each for each ecosite phase, based on the relative species ratios from the *Field Guide to Ecosites of Northern Alberta*, 1996, J. D. Beckingham and J. H. Archibald
- Labrador tea is a key indicator in ecosite phases c and d. However, the species is often provided through direct placement of muskeg soils.

Revegetation Plan (cont'd)

- species stocking is naturally variable in ecosite phases. A recommended convention is to allow variation of species stocking by 10% of the chart numbers.
- shrub species have been recommended based on ecosite prominence identified in the *Field Guide to Ecosites of Northern Alberta*, 1996, for the Athabasca Plains Natural Subregion. Additional species will be added to the prescription if the species are consistent with those identified in the field guide.
- ecosite phases e2 and e3 have willow as a common shrub species and are available through direct placement of soil from muskeg sources, depending on the degree of disturbance when the soil is not frozen

Table 20-9: Target Ecosite Phase Planting Prescriptions for Pierre River Mine Area

Reclaimed Soil Series	Reclaimed Soil Capping [1] (Depth + 5 cm)	Landscape Feature	Moisture Regime and Soil Capability	Target Ecosite Phase	Tree Species (Total Density of 1,800 to 2,200 Stems/ha)	Shrub/Forbs (Total Density of 500 to 700 Stems/ha)
E	50 cm peat–mineral mix 30 cm fine-textured overburden	Toe of slopes on OBDA	Soil Class 1 (subhygric)	e2 willow/horsetail-aspen-white spruce-black spruce	White spruce, aspen, black spruce	Rose, willow, buffalo berry, horsetail
	40 cm peat–mineral mix 30 cm fine textured overburden	North-facing mid-slope of OBDA	Soil Class 2 (mesic)	e3 willow/horsetail-white spruce-black spruce	White spruce, black spruce	Rose, willow, buffalo berry, horsetail
I	20 cm of peat–mineral mixture and overburden or natural soil	Well-drained mid-slopes adjacent to capped tailing cells	Soil Class 4 (mesic, subhygric)	b2 Canada buffalo berry-green alder-aspen	Aspen	Buffaloberry, rose, green alder
M	20 cm coarse-textured upland coversoil 30 cm medium-textured upland subsoil medium-textured overburden	Lower slope positions of contoured capped tailings cells and ETDA, all aspects Slopes and crests of berms and ridges	Soil Class 4 (mesic) Soil Class 3 (subhygric) Soil Class 2 (hygric)	c1 Labrador tea-jack pine-black spruce	Jack pine, black spruce	Labrador tea, bog cranberry, blueberry

Table 20-9: Target Ecosite Phase Planting Prescriptions for Pierre River Mine Area (cont'd)

Reclaimed Soil Series	Reclaimed Soil Capping [1] (Depth + 5 cm)	Landscape Feature	Moisture Regime and Soil Capability	Target Ecosite Phase	Tree Species (Total Density of 1,800 to 2,200 Stems/ha)	*Shrub/Forbs (Total Density of 500 to 700 Stems/ha)*
Ms	20 cm coarse-textured upland coversoil 30 cm medium-textured upland subsoil Medium-textured overburden	ETDA and capped tailings cells in depressional areas near drainage channels, all aspects Saline areas	Soil Class 4 (subhygric)	d1 Labrador tea (subhygric)-black spruce-jack pine	Black spruce, jack pine, white birch	Labrador tea, bog cranberry, blueberry
N	20 cm medium-textured upland coversoil 30 cm medium-textured upland subsoil Medium-textured overburden	Crest, upper and mid-slope positions of contoured capped tailings cells, all aspects Upper slope of ETDA Mid-slope of south aspect on OBDA	Soil Class 3 (mesic)	b2 Canada buffalo berry-green alder-aspen	Aspen	Buffaloberry, rose, green alder
		Crest, upper and mid-slope positions of contoured capped tailings cells, all aspects OBDAs, level positions and mid slope of east and west aspects	Soil Class 2 (subhygric)	b3 Canada buffalo berry-green alder-aspen-white spruce-black spruce	Aspen, white spruce, black spruce	Buffaloberry, green alder, Labrador tea
P	10 to 15 cm coarse coversoil 85 to 90 cm coarse-textured subsoil Medium-textured overburden	Crest and south-facing slope of OBDA	Soil Class 3 (mesic)	a1 bearberry-jack pine	Jack pine	blueberry, bearberry, bog cranberry
S	No soil replacement	Undisturbed areas	Natural soil capability class	N/A	N/A	N/A

Note: Adapted from *Guidelines for Reclamation of Terrestrial Vegetation in the Oil Sands Region*, OSVRC, 1998.
Reclaimed soil layers are listed from surface downwards, by layer.

Table 20-10: Shrubland Planting Prescriptions for Pierre River Mine

Shrubland Phase	Reclaimed Soils [1] (Depth ± 5 cm)	Landscape Feature	Shrub Species	Forbs
Shrublands 2 (Sh2)	30 cm peat overburden	Wet and non-sodic drainages	Hoary willow, grey-leaved willow, buffaloberry, dwarf birch, river alder, green alder	Buck bean, marsh cinquefoil, vernal water-starwort
Shrublands 3 (Sh3) [2]	30 cm peat overburden	35 m buffer surrounding all potentially saline drainage areas, and margins surrounding open water	Willow sp., swamp birch	Alkali bulrush, common cattail, awned sedge, northern reed grass

Note:

1. Reclaimed soil layers are listed from surface downwards, by layer.
2. Saline-tolerant shrubs in Sh3 will be grown in a 35 m band, 20 m away from the lowest point of depression. Saline-tolerant forbs will be grown in the 20 m nearest the lowest point of the depression.

MONITORING PROGRAMS

Shell conducts annual monitoring programs on reclaimed areas at its existing Muskeg River Mine to assess:

- herbaceous vegetation growth
- major species composition
- the physical and chemical properties of soils on all the reclaimed areas

Shell will structure its monitoring program at the Pierre River Mine to align with its monitoring programs at its existing operations. The program will:

- monitor soil and vegetation on the reclaimed sites
- assess tree and woody-stemmed plants on the reclaimed sites
- assess wildlife use of areas reclaimed within and areas adjacent to the Pierre River Mine

The monitoring programs specified for the Muskeg River Mine and Jackpine Mine – Phase 1 areas will form the basis of programs at the Pierre River Mine and, where appropriate, may be expanded to include the Pierre River Mine.

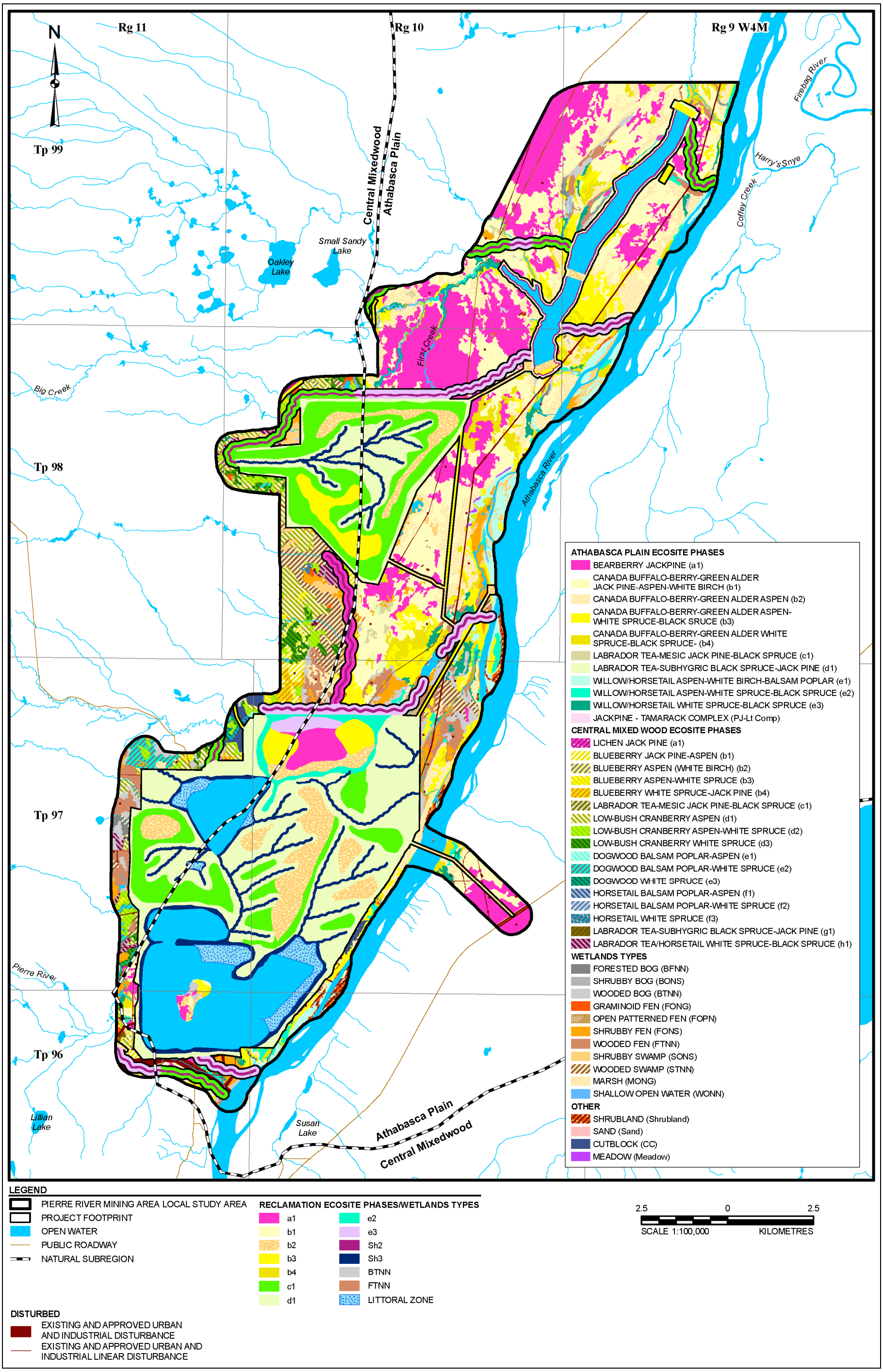


Figure 20-3: Reclamation Planting Prescriptions for Ecosite Phases and Wetland Types

MINE RECLAMATION

Table 20-11 summarizes Shell's proposed mining and reclamation activities at the Pierre River Mine.

The following figures provide the annual mining and reclamation progression for the Pierre River Mine area between 2010 and 2019, and at the end of the mine in 2039:

Figure 20-4: Mining and Reclamation Progression in 2010
Figure 20-5: Mining and Reclamation Progression in 2011
Figure 20-6: Mining and Reclamation Progression in 2012
Figure 20-7: Mining and Reclamation Progression in 2013
Figure 20-8: Mining and Reclamation Progression in 2014
Figure 20-9: Mining and Reclamation Progression in 2015
Figure 20-10: Mining and Reclamation Progression in 2016
Figure 20-11: Mining and Reclamation Progression in 2017
Figure 20-12: Mining and Reclamation Progression in 2018
Figure 20-13: Mining and Reclamation Progression in 2019
Figure 20-14: Mining and Reclamation Progression in 2039

The reclamation progression figures illustrate the areas of soil material salvage, contouring and revegetation. Progressive reclamation will be implemented, including direct placement of the reclamation material, when salvage and reclamation can occur concurrently.

Table 20-11: Pierre River Mine Area Mining and Reclamation Activities

Project Activities	Mining Activities	Reclamation Activities
Pre-mining		
Drilling core holes	•	
Exploring for gravel	•	
Drilling overburden	•	
Mining		
Clearing and grubbing trees, and burning slash	•	
Dewatering muskeg and overburden	•	
Depressurizing the basal aquifer	•	
Salvaging soil		•
Removing overburden	•	
Excavating the oil sands	•	
Backfilling the mine	•	
Capping and stabilizing the non-segregated tailings	•	•
Contouring the overburden	•	•
Placing reclamation material (including direct placement opportunities)		•
Seeding for revegetation		•
Fertilizing		•
Conducting reclamation monitoring		•
Conducting geotechnical monitoring	•	
Conducting reclaimed land management		•
Closure		
Removing equipment		•
Implementing site remediation		•
Completing reclamation		•
Monitoring landform stability		•
Closing the landfill (including monitoring water quality)		•
Assessing the quality of tailings deposit release water		•
Conducting reclamation monitoring on soils, vegetation and surface water		•
Applying for a reclamation certificate		•

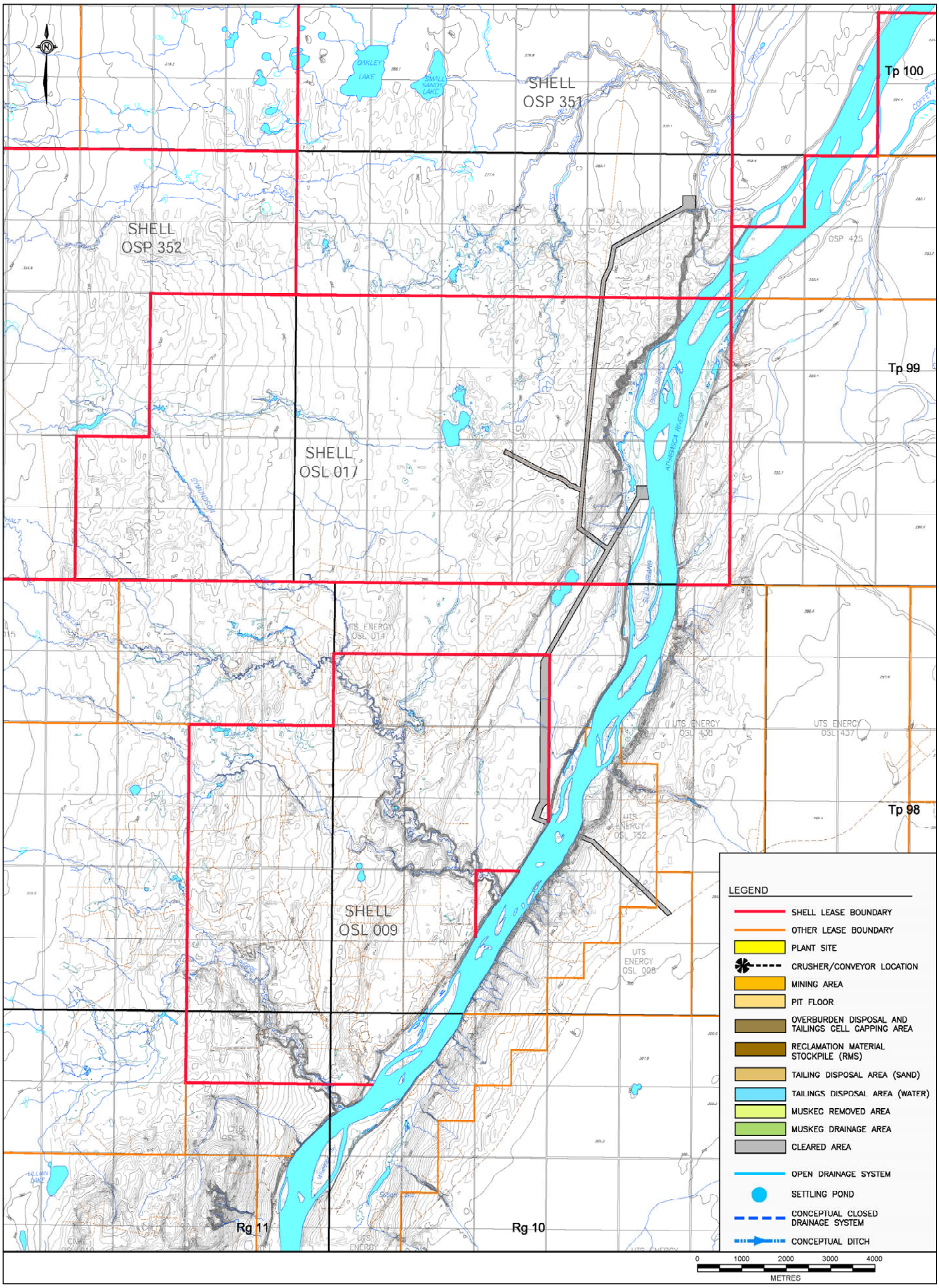


Figure 20-4: Mining and Reclamation Progression for the Pierre River Mine Area in 2010

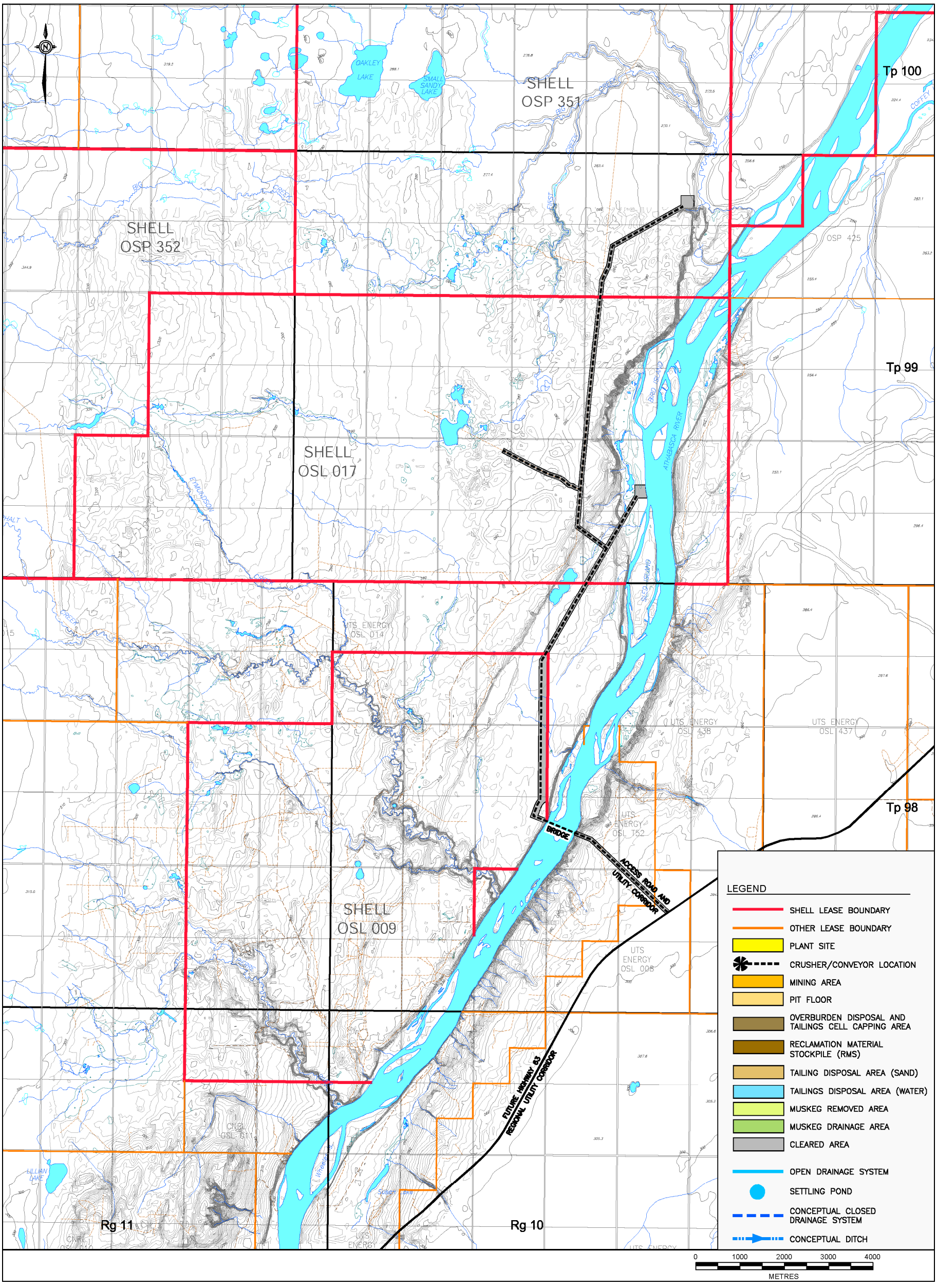


Figure 20-5: Mining and Reclamation Progression for the Pierre River Mine Area in 2011

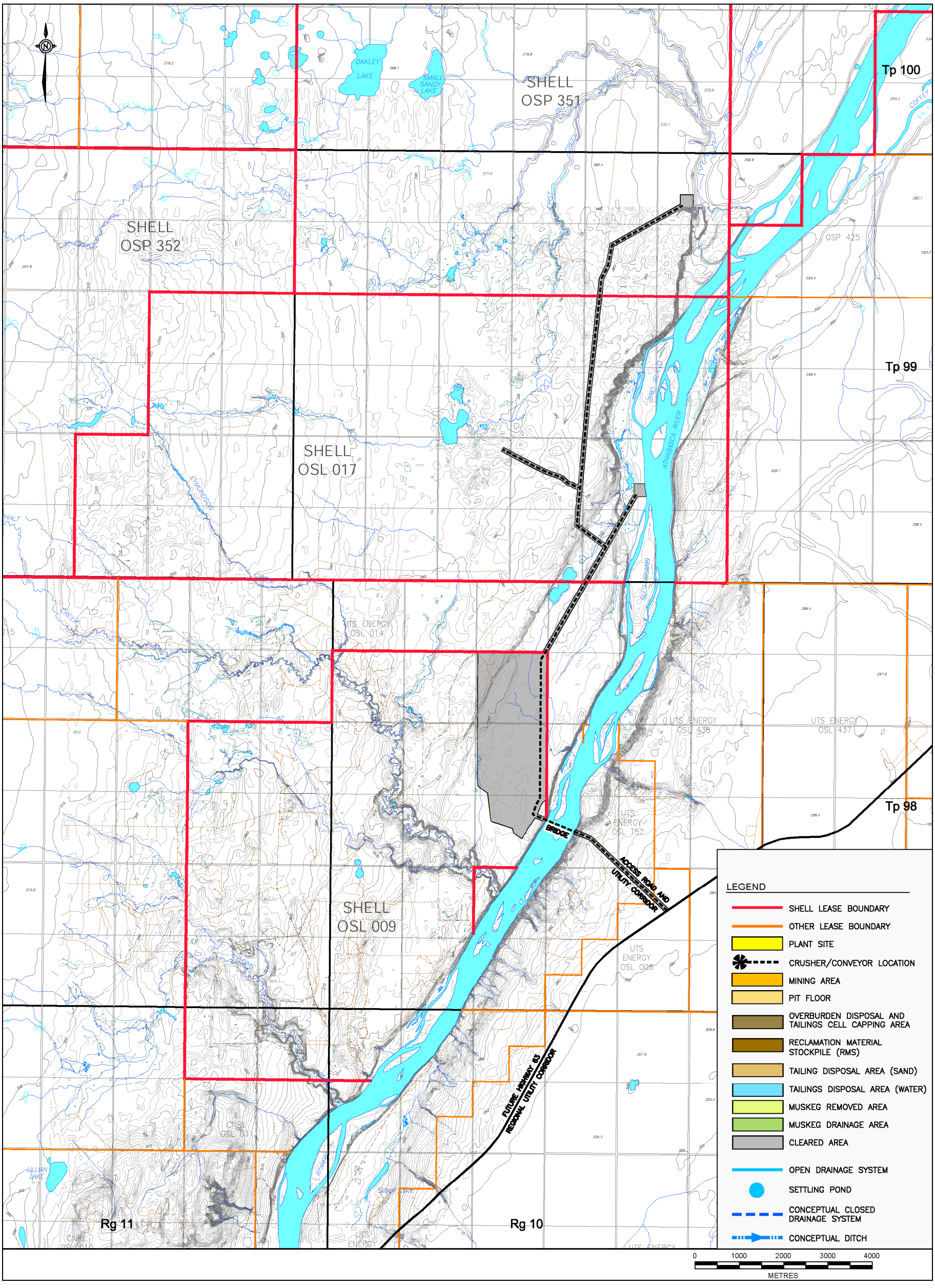


Figure 20-6: Mining and Reclamation Progression for the Pierre River Mine Area in 2012

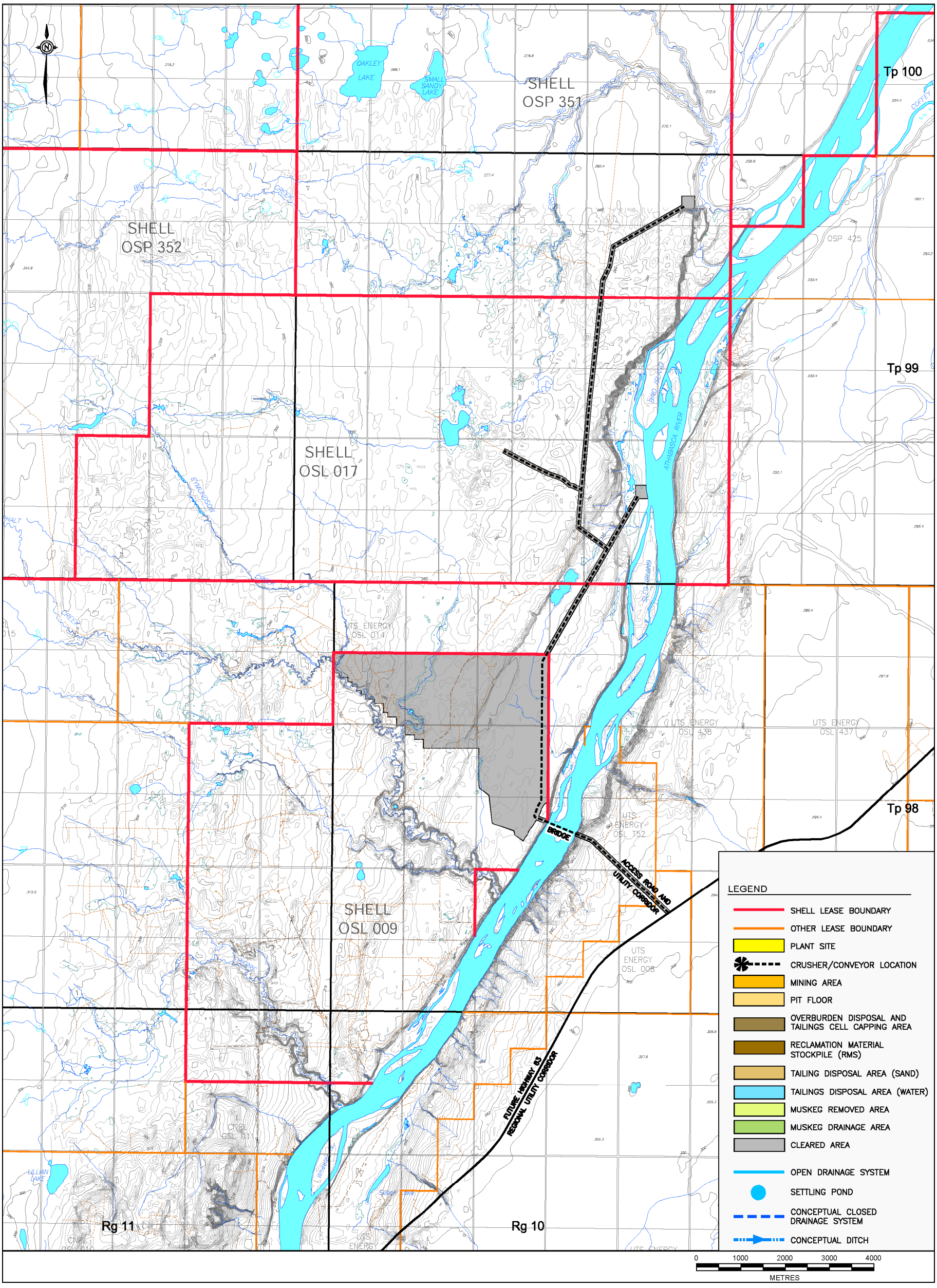


Figure 20-7: Mining and Reclamation Progression for the Pierre River Mine Area in 2013

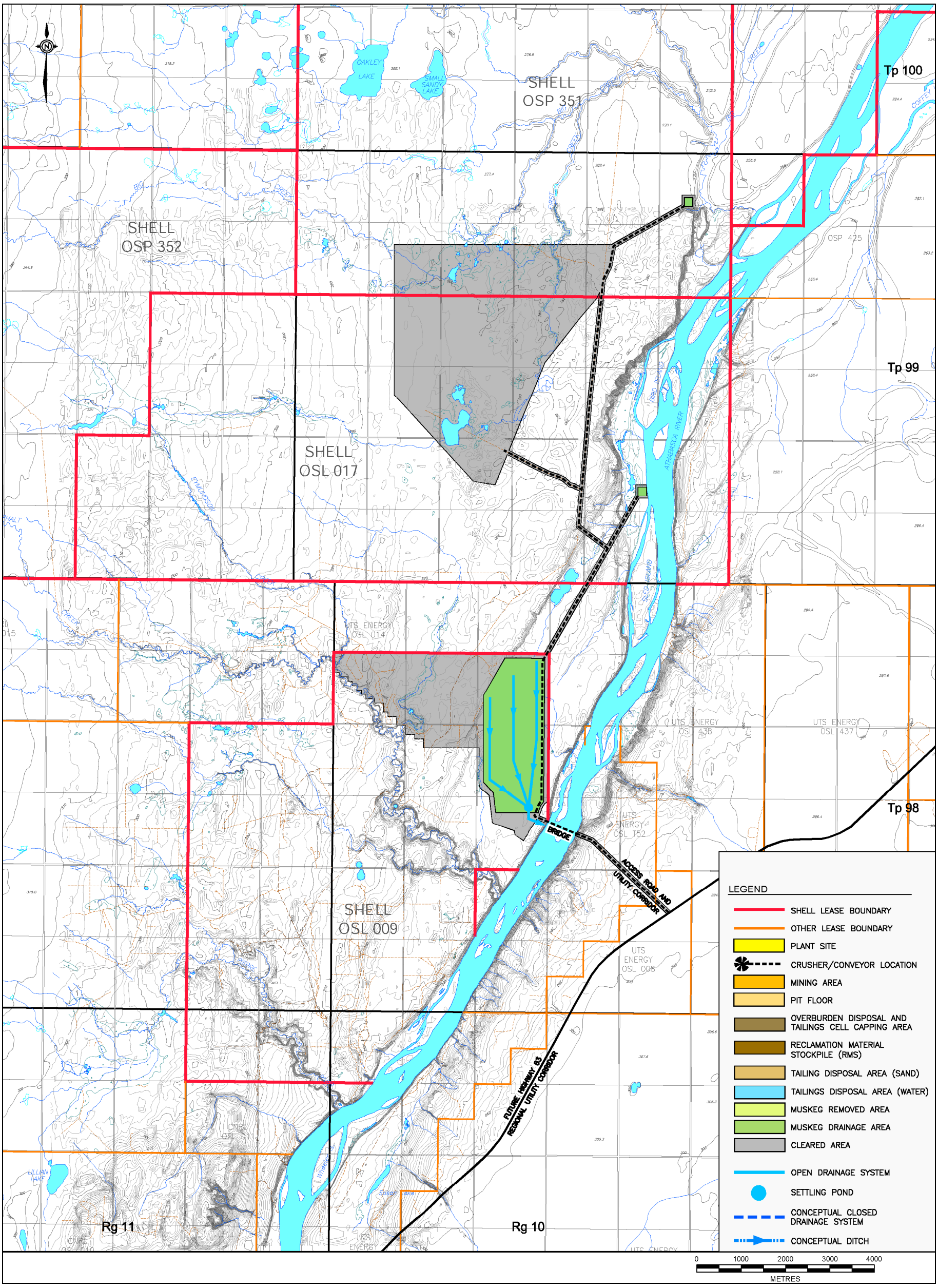


Figure 20-8: Mining and Reclamation Progression for the Pierre River Mine Area in 2014

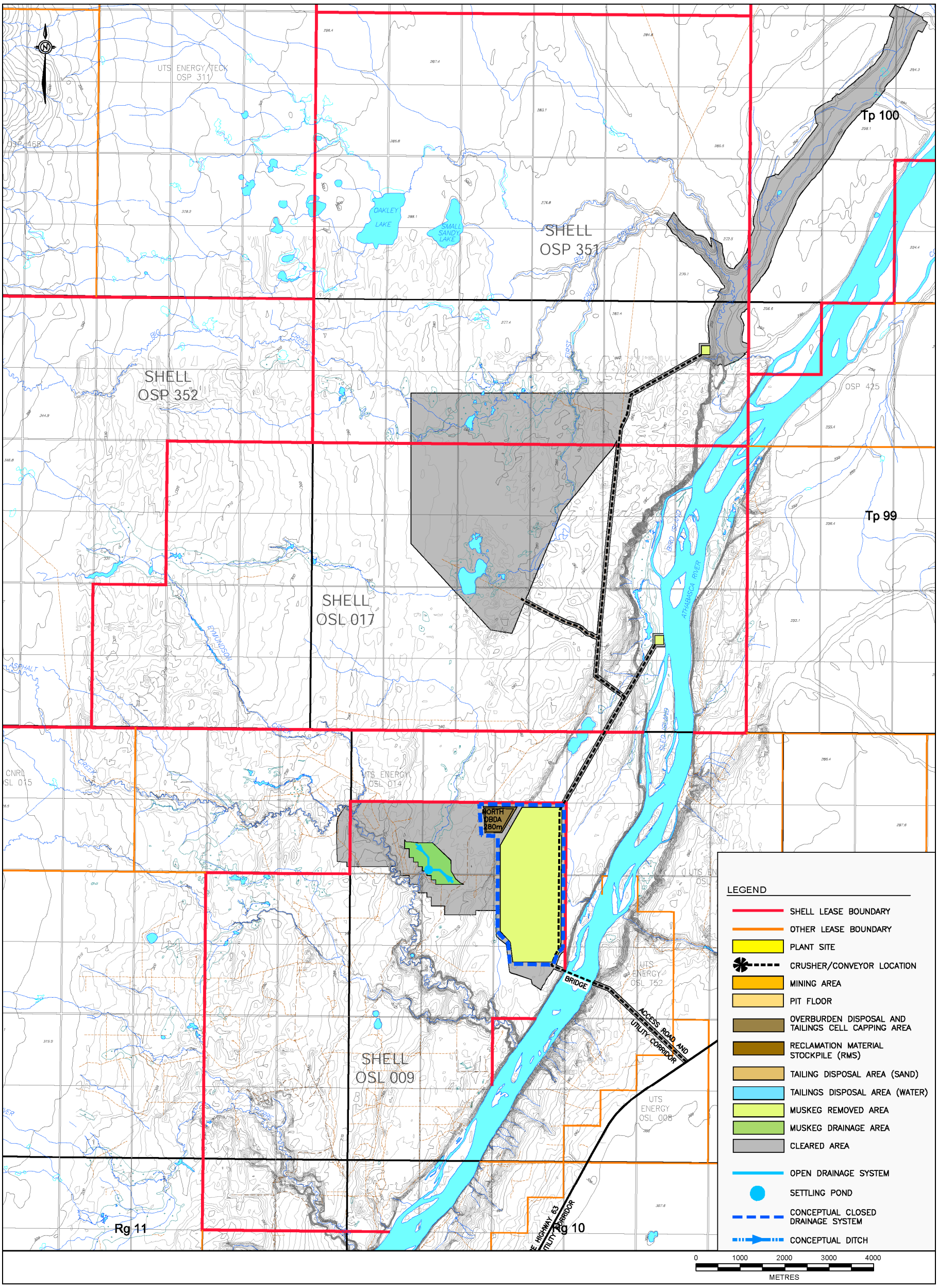


Figure 20-9: Mining and Reclamation Progression for the Pierre River Mine Area in 2015

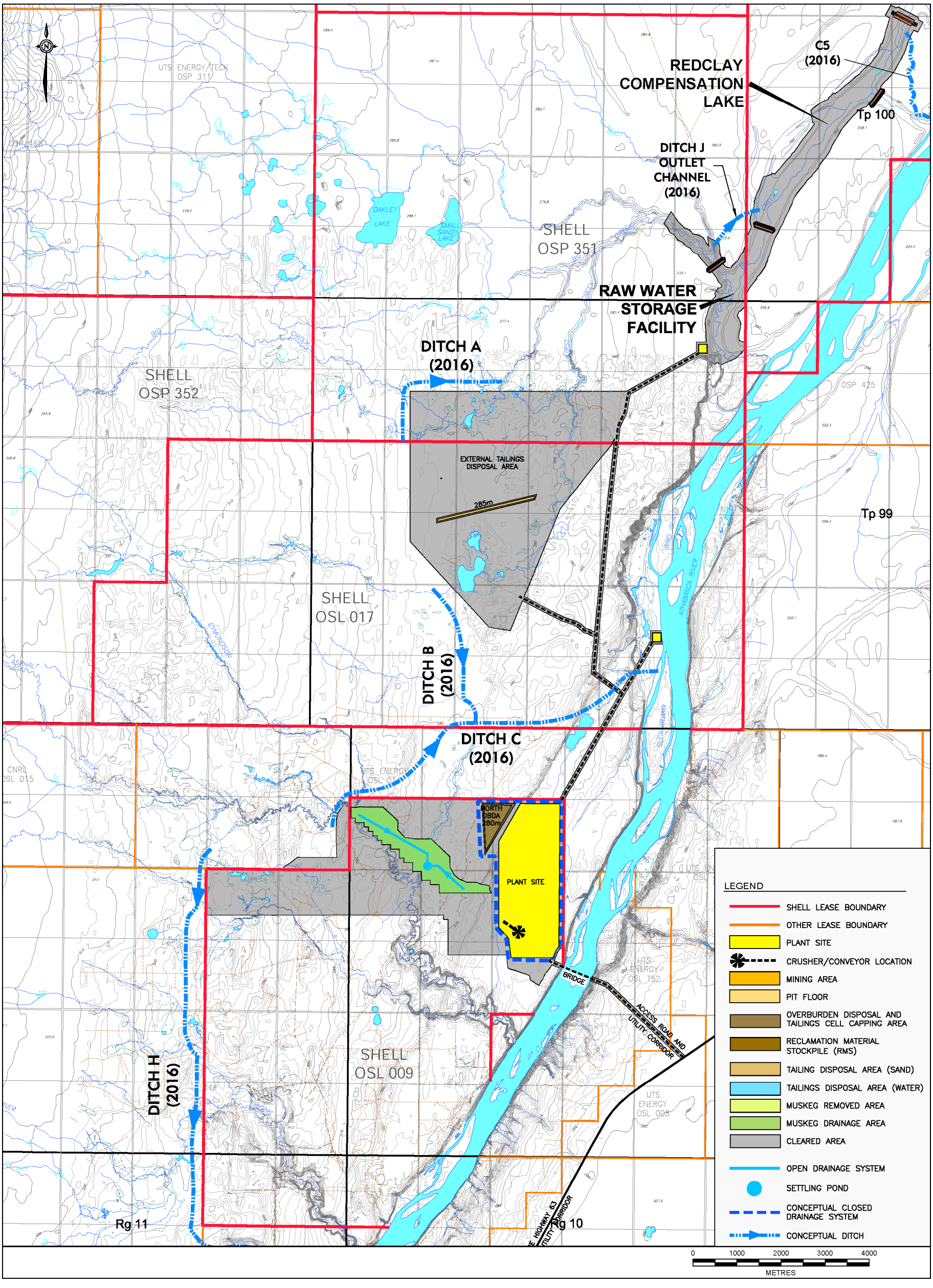


Figure 20-10: Mining and Reclamation Progression for the Pierre River Mine Area in 2016

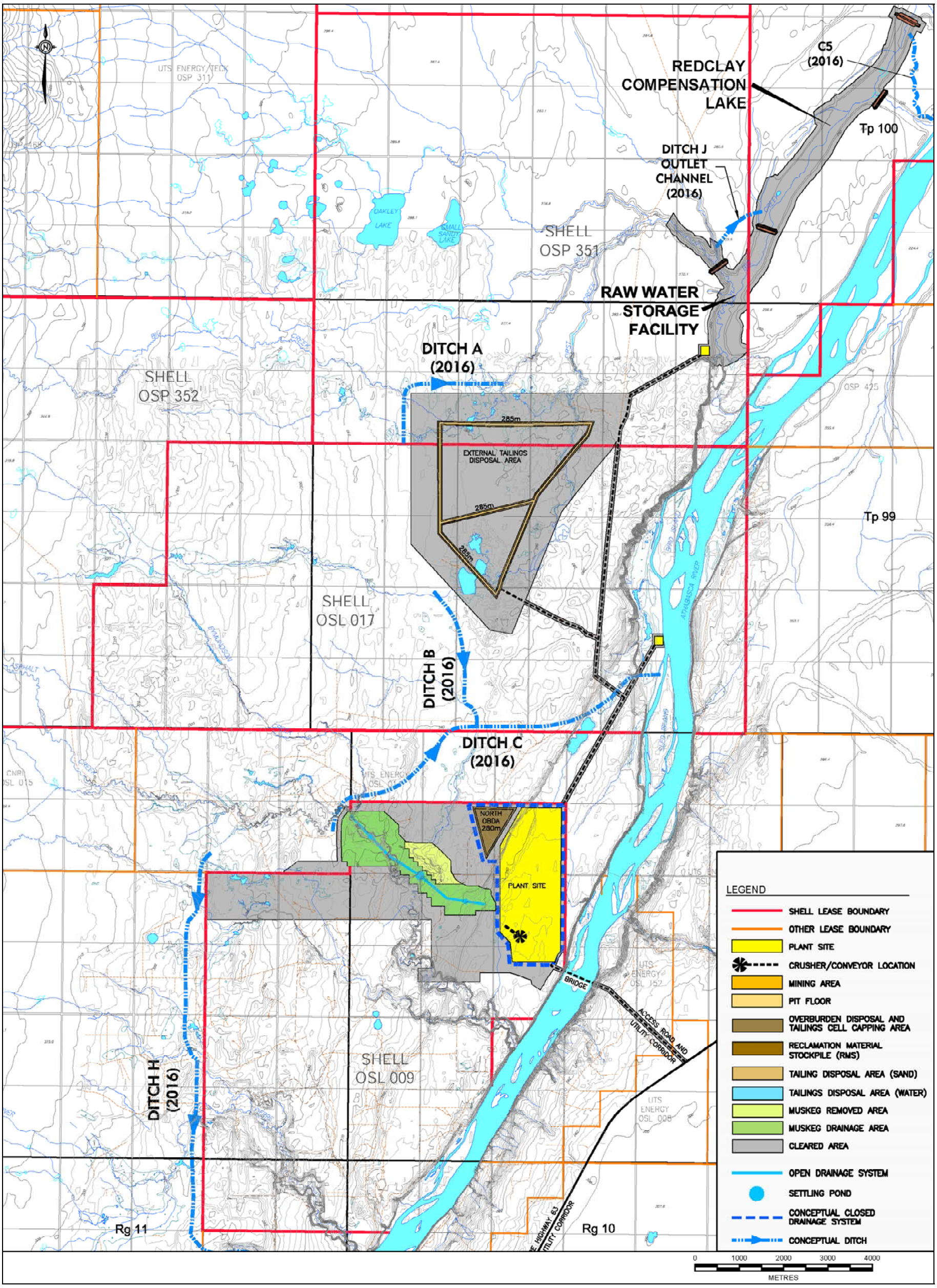


Figure 20-11: Mining and Reclamation Progression for the Pierre River Mine Area in 2017

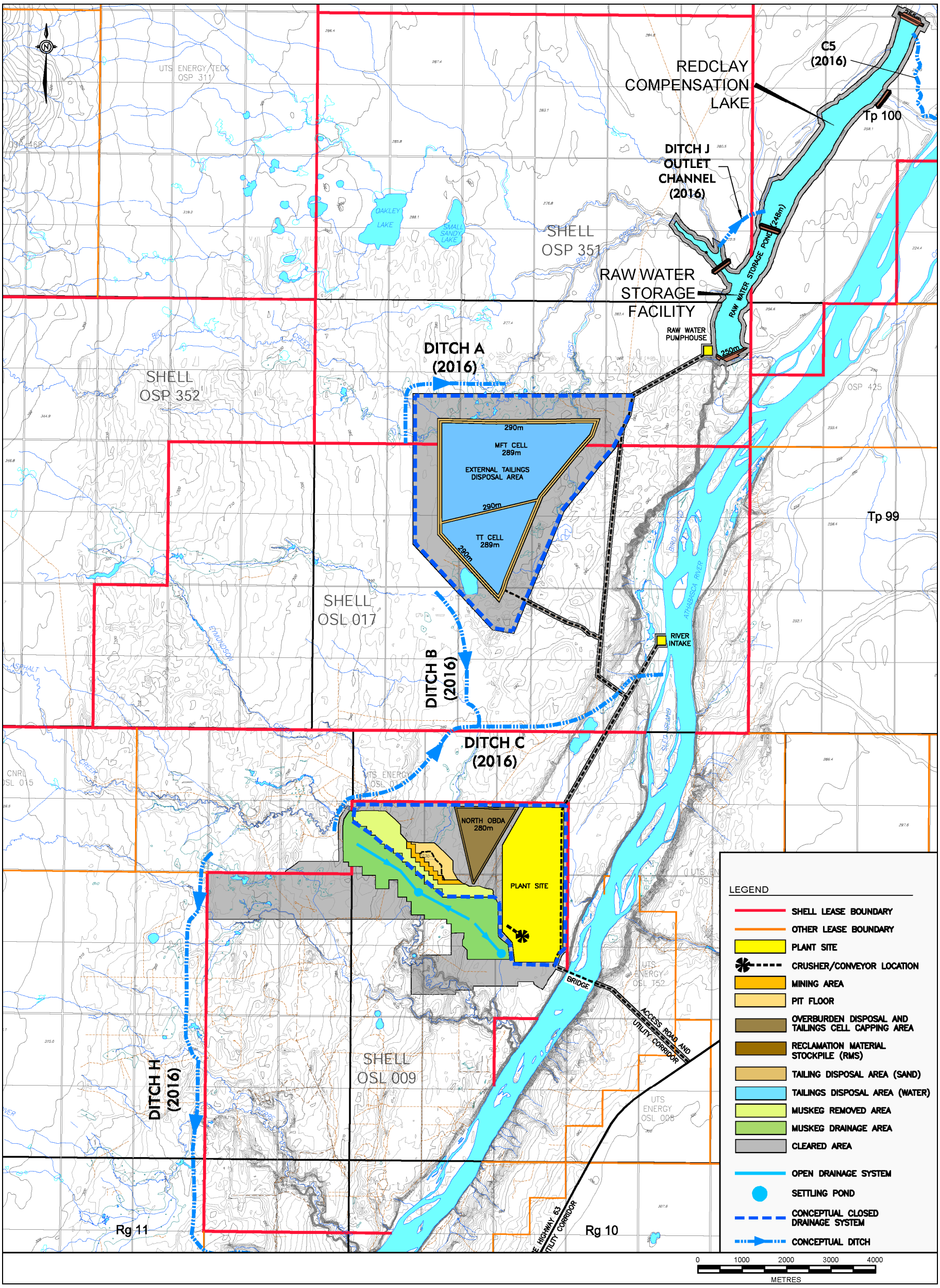


Figure 20-12: Mining and Reclamation Progression for the Pierre River Mine Area in 2018

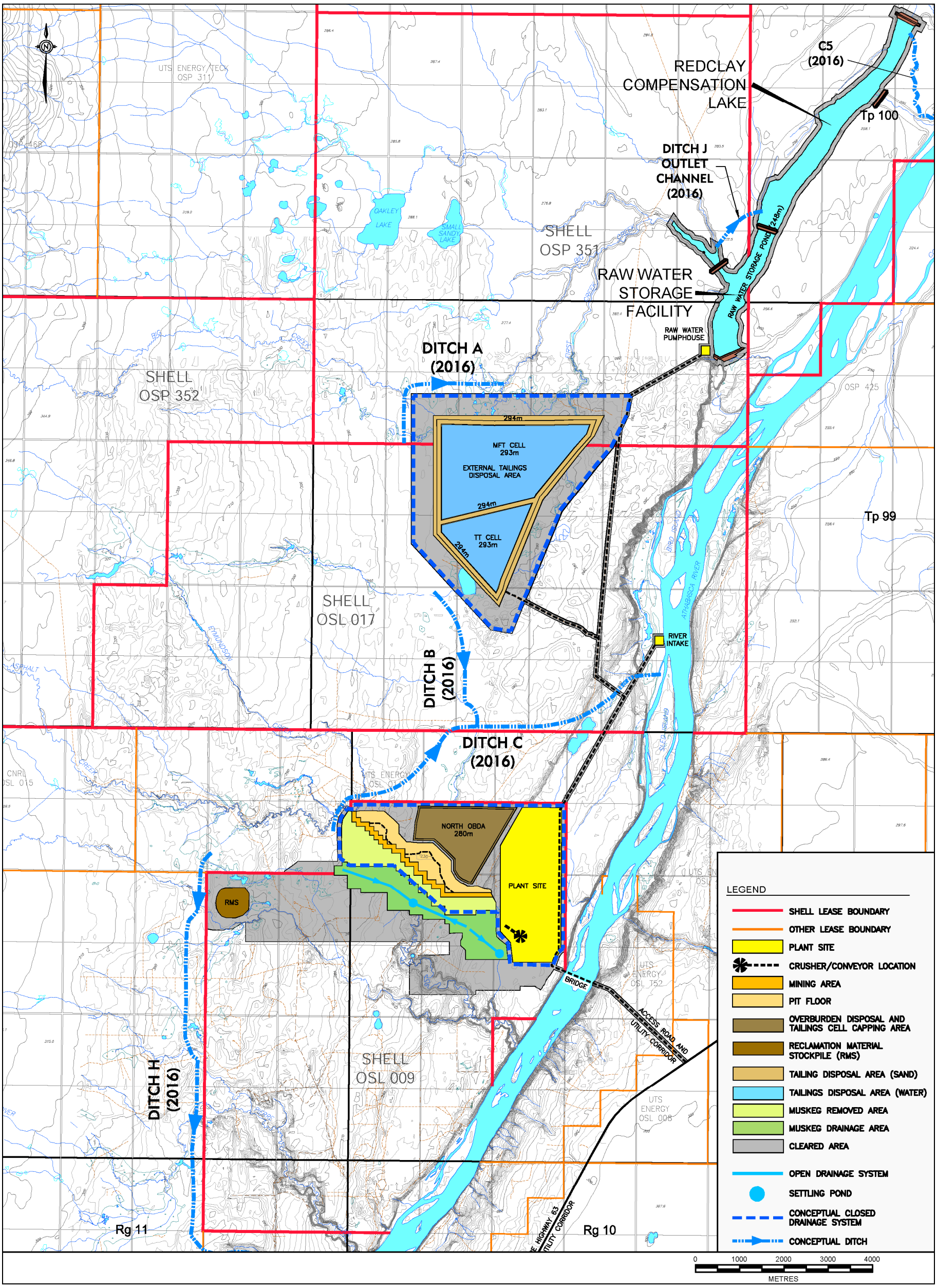


Figure 20-13: Mining and Reclamation Progression for the Pierre River Mine Area in 2019

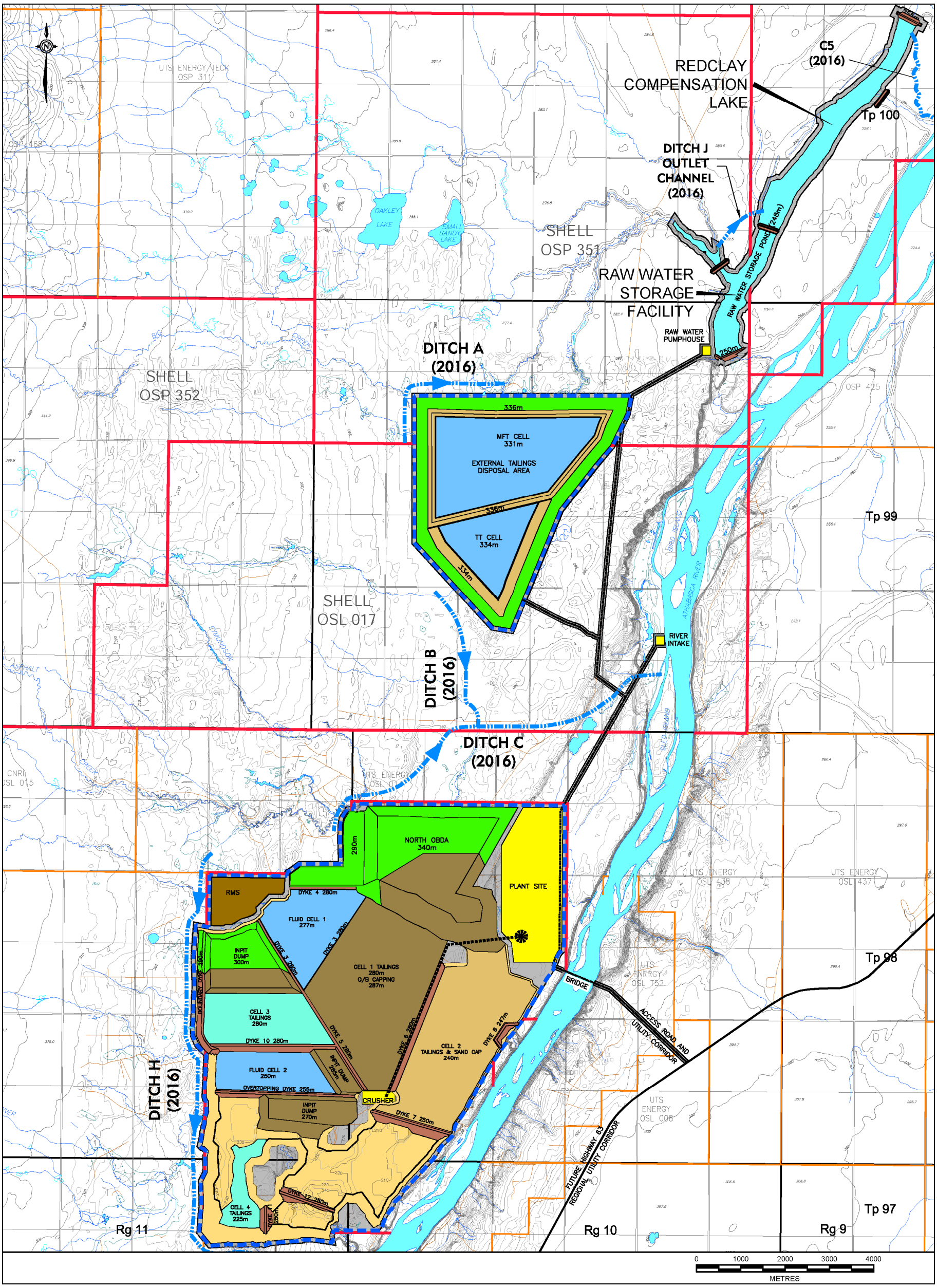


Figure 20-14: Mining and Reclamation Progression for the Pierre River Mine Area in 2039

GLOSSARY

%	The symbol for percent.
<	The symbol for less than.
>	The symbol for greater than.
°C	The symbol for degrees Celsius.
µm	The symbol for micron.
3-D	The abbreviation for three dimensional.
7Q10	The lowest seven-day consecutive flow that occurs on average, once every 10 years.
a	The metric symbol for year.
AAAP	The abbreviation for Alberta Aboriginal Apprenticeship Program.
AAAQO	The abbreviation for Alberta Ambient Air Quality Objectives.
AAP	The abbreviation for Alberta Apprenticeship Program.
absorption	The penetration of a substance into the body of another substance.
ACFN	The abbreviation for Athabasca–Chipewyan First Nation.
acidification	The decrease of acid neutralizing capacity in water, or base saturation in soil, caused by natural or anthropogenic processes. Acidification is exhibited as the lowering of pH, which can adversely affect aquatic life.
acute exposures	Exposures occurring over a short period of time, usually at high concentrations.
adaptive management	A continuous improvement process of planning, implementing and evaluating results through monitoring and research programs and developing new plans from the lessons learned. This process will allow for development of best practices through continuous learning and renewal of plans.

adsorption	The surface retention of solid, liquid or gas particles by a solid or liquid.
adverse effect	An undesirable or harmful effect to an organism (human, animal or plant) indicated by some result, such as mortality, altered food consumption, altered body and organ weights, altered enzyme concentrations or visible pathological changes.
AENV	The abbreviation for Alberta Environment.
AER	The abbreviation for asphaltene energy recovery.
aerial	Relating to the air or atmosphere.
aggregate	Pieces of crushed stone, gravel and other material used in making concrete.
AHIP	The abbreviation for Affordable Housing Investment Corporation.
AHRC	The abbreviation for Aboriginal Human Resources Council.
ALARP	The abbreviation for as low as reasonably practicable.
Albian Sands	The abbreviation for Albian Sands Energy Inc.
ambient	The conditions surrounding an organism or area.
AMIRA	The abbreviation for Australian Mineral Industry Research Association.
AMSA	The abbreviation for Alberta Municipal Supervisors Association.
AOSP	The abbreviation for Athabasca Oil Sands Project.
Application Case	The environmental effects of the proposed projects, combined with the effects identified in the Base Case. The Application Case was used for a direct comparison with the Base Case results, to predict the changes that result from the Jackpine Mine Expansion and the Pierre River Mine Project.
aquatic	Growing, living in or frequenting water. Also, occurring or situated in or on water.
aquifer	A water-saturated, permeable body of rock capable of transmitting significant or usable quantities of groundwater to wells and springs under ordinary hydraulic gradients.
ASEP	The abbreviation for Aboriginal Skills and Employment Partnership.
ASL	The abbreviation for acid sensitive lake.
ASRD	The abbreviation for Alberta Sustainable Resource Development.

AST	The abbreviation for alternative steering team.
ATC	The abbreviation for Athabasca Tribal Council.
ATPRC	The abbreviation for Alberta Tourism, Parks, Recreation and Culture.
attenuation, noise	The process of reducing noise levels.
backfill	To refill an excavated hole with the material dug out of it.
background	An area not influenced by chemicals released from the site under evaluation.
bank cubic metre	A cubic metre of material in place.
basal aquifer	Permeable rock, deep below the surface, that is saturated with water.
Base Case	The existing environmental conditions and the environmental effects of existing and approved developments that might overlap with the environmental impacts of the proposed projects.
baseline	A surveyed or predicted condition that serves as a reference point on which later surveys are coordinated or correlated.
basin	An entire area drained by a given river and its tributaries.
BATEA	The abbreviation for best available technology economically achievable.
BAW	The abbreviation for beach-above water.
bbl	The abbreviation for barrel.
bbl/yr	The abbreviation for barrels per year.
BBW	The abbreviation for beach-below water.
bcm	The abbreviation for bank cubic metres.
bedrock	The body of rock that underlies gravel, soil or other superficial material.
benthic invertebrates	Invertebrate organisms living at, in or in association with, the bottom (benthic) substrate of lakes, ponds and streams.
berm	A mound or wall of earth.
biocide	A chemical agent that destroys pests. Also known as *pesticide*.
biodiversity	The variety of organisms and ecosystems that comprise both the communities of organisms within particular habitats and the physical conditions under which they live.

bioremediation	The process by which living organisms act to degrade or transform hazardous organic contaminants.
bitumen	A naturally occurring viscous mixture, mainly of hydrocarbons heavier than pentane, that might contain sulphur compounds and that, in its naturally occurring state, will not flow to a well.
blowdown	The act of emptying or depressurizing material in a vessel.
bog	A peat-covered area or peat-filled wetland, generally with a high water table.
boreal	Of the north or northern regions.
borehole	A hole made by drilling or boring.
C&R	The abbreviation for conservation and reclamation.
C,C&R	The abbreviation for closure, conservation and reclamation.
calibration	The process of adjusting or standardizing a measuring instrument.
Canadian Natural	The abbreviation for Canadian Natural Resources Limited.
CANMET	The abbreviation for Canadian Centre for Mineral and Energy Technology.
capability, soil	An evaluation of soil performance that focuses on the degree and nature of limitation imposed by the physical characteristics of the soil unit on a certain use, such as agriculture, forestry or recreation.
CAPP	The abbreviation for Canadian Association of Petroleum Producers.
CCC	The abbreviation for Community Careers Cooperative.
CCD	The abbreviation for countercurrent decantation.
CCME	The abbreviation for Canadian Council of Ministers of the Environment.
cd	The abbreviation for calendar day.
CDA	The abbreviation for Canadian Dam Association.
CEAA	The abbreviation for Canadian Environmental Assessment Association.
CEMA	The abbreviation for the Cumulative Environmental Management Association.
CEPA	The abbreviation for *Canadian Environmental Protection Act*.
CFD	The abbreviation for computational fluid dynamics.

channel	The bed of a river, stream or other watercourse, or a length of water wider than a strait joining two larger areas.
closure plan	A plan for the permanent closure of all or part of a mine or industrial facility, including removing process equipment, buildings and other structures, decontaminating the surface and subsurface, replacing soil, revegetating, designating end land uses and monitoring to ensure long-term performance.
cm	The metric symbol for centimetre.
CNRL	The abbreviation for Canadian Natural Resources Limited.
CO	The chemical formula for carbon monoxide.
CO_2	The chemical formula for carbon dioxide.
cogeneration	The simultaneous on-site generation of electrical power and process steam or heat from the same plant.
connate water	Water, usually highly mineralized, entrapped in the interstices of igneous rocks when the rocks were formed.
CONRAD	The abbreviation for Canadian Oil Sands Network for Research and Development.
conservation	The planning, management and implementation of an activity with the objective of protecting the essential physical, chemical and biological characteristics of the environment against degradation.
consolidated tailings	A non-segregating mixture of process plant tailings that consolidates quickly in tailings deposits.
contingency plan	The measures in place to prepare for events that might, but are not certain to, occur.
contouring	The process of shaping the land surface to fit the form of the surrounding land.
control	Observations made on subjects that have not undergone treatment, to use in comparison with observations made on subjects that have undergone treatment. In a toxicity test, a control duplicates all the conditions of exposure treatments but contains no test material. The control is used to determine basic test conditions in the absence of toxicity (e.g., health of test organisms, quality of dilution water).
coversoil	Any topsoil, including the litter layer, or any organic soil, or any material rated as good or fair according to Alberta Agriculture's *Soil Quality Criteria Relative to Disturbance and Reclamation.*

critical load A quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge. For waterbody acidification, the critical load represents an estimate of the amount of acidic deposition below which significant adverse changes are not expected to occur in a lake's ecosystem.

CSA The abbreviation for Canadian Standards Association.

CST The abbreviation for coarse sand tailings.

CT The abbreviation for consolidated tailings.

CUT The abbreviation for cyclone underflow tailings.

d The abbreviation for day.

development area All areas to be disturbed for the project on and off Lease 13, including the overburden disposal area, reclamation stockpile areas, mine pit, external tailings disposal area, plant site, right-of-ways, Khahago Creek diversion, Kearl Lake outlet dam, Muskeg Creek realignment, and the new Kearl Lake outlet.

DFO The abbreviation for Department of Fisheries and Oceans.

dilbit The abbreviation for diluted bitumen.

discharge In a stream or river, the volume of water that flows past a given point in a unit of time (e.g., m^3/s).

dissolved oxygen Oxygen that is present (dissolved) in water and is, therefore, available for fish and other aquatic organisms. It is normally measured in mg/L (equivalent to ppm) and widely used as a criterion of water quality.

disturbance A force that causes significant change in the structure and composition of a habitat (e.g., clearing for a mine pit or a well pad).

diversion An artificial watercourse created to divert the flow of water from one body to another or to provide drainage.

diversity The variety, distribution and abundance of different plant and animal communities and species within an area.

drainage The removal of groundwater or surface water, or water from structures, by gravity or pumping.

drawdown The distance the water surface of a reservoir is lowered from a given elevation as the result of releasing water. Drawdown can be expressed in terms of the acre-feet of stored water released.

DW	The abbreviation for Devonian Waterways.
dyke	A bank of earth constructed to confine water.
ecological	Relating to ecology.
ecosite	Ecological units that develop under similar environmental influences (climate, moisture and nutrient regime). Ecosites are groups of one or more ecosite phases that occur within the same portion of the moisture/nutrient grid. Ecosite is a functional unit defined by the moisture and nutrient regime. It is not tied to specific landforms or plant communities, but is based on the combined interaction of biophysical factors that together dictate the availability of moisture and nutrients for plant growth.
ecosystem	An integrated and stable association of living and nonliving resources functioning within a defined physical location.
effluent	A stream of water discharging from a source.
EIA	The abbreviation for Environmental Impact Assessment.
elevation	The height above a given level, especially sea level.
emissions	Substances discharged into the atmosphere through a stack.
EMS	The abbreviation for Environmental Management System.
end land use	The development or redevelopment of land or water areas for a defined purpose at closure.
end-pit lake	An artificial lake, used to fill the void at one end of a mine, into which the remaining fine tailings at the end of mine life are discharged and stored under a water cap.
environmental impact assessment	A review of the effects that a proposed development will have on the local and regional environment.
EPA	The abbreviation for Environmental Protection Agency.
EPCM	The abbreviation for engineering, procurement and construction management.
EPEA	The abbreviation for *Environmental Protection and Enhancement Act*.
erosion	The process by which material, such as rock or soil, is worn away or removed by wind or water.
ETDA	The abbreviation for external tailings disposal area.
EUB	The abbreviation for the Alberta Energy and Utilities Board.

evaporation	The process by which water is transferred from open water surfaces to the atmosphere.
external tailings disposal area	An artificial impoundment structure outside of the mine to contain tailings. The tailings disposal area is enclosed by dykes made to stringent geotechnical standards, using tailings and overburden materials.
extraction	The process of separating bitumen from oil sands, using warm water and steam.
FFT	The abbreviation for fluid fine tailings.
FGD	The abbreviation for flue gas desulphurization.
fibric	Organic materials containing large amounts of weakly decomposed fibres whose botanical origins are readily identifiable.
fines	Silt and clay particles.
fish tainting	Fish contamination.
fisheries	Fishing grounds or areas where fish are caught.
flaring	Disposing of surplus combustible vapours by igniting them in the atmosphere.
flocculant	A reagent added to a dispersion of solids in a liquid to bring together the fine particles to form flocs.
FMFN	The abbreviation for Fort McKay First Nation.
footprint	The amount and shape of the area occupied.
froth, bitumen	Air-entrained bitumen with a froth-like appearance that is the product of the primary extraction step in a warm or hot water extraction process.
FRP	The abbreviation for Forest Resource Planning.
fugitive emissions	Trace amounts of uncombusted substances that are released into the atmosphere during normal facility and plant operations.
GDP	The abbreviation for gross domestic product.
geology	The study or science of the earth, its history, and its life as recorded in the rocks. It includes the study of geologic features of an area, such as the geometry of rock formations, weathering and erosion and sedimentation.
geomorphology	The branch of science that deals with the form of the earth, the general configurations of its surface, and the changes that take place in the evolution of landforms.

geotechnical	Related to the application of scientific methods and engineering principles to civil engineering problems, by acquiring, interpreting and using knowledge of materials of the crust of the earth.
GJ/h	The metric symbol for gigajoules per hour.
glacial deposit	Unsorted sedimentary material deposited directly by and underneath a glacier, consisting of a mixture of clay, silt, sand, gravel and boulders. Also known as *till*.
glaciofluvial	Relating to streams fed by melting glaciers or to the deposits and landforms produced by such streams.
graminoid fen or marsh	Wetlands dominated by grass or sedge species.
greenhouse gases	Any of various gases, especially carbon dioxide, that contribute to the greenhouse effect.
GRG	The abbreviation for Groundwater Research Group.
groundwater	Subsurface water that occurs beneath the water table in soils and geological formations that are fully saturated. It is the water within the earth that supplies water wells and springs.
GTG	The abbreviation for gas turbine generator.
h	The metric symbol for hour.
ha	The metric symbol for hectare.
habitat	The part of the physical environment in which a plant or animal lives.
HEMP	The abbreviation for hazards and effects management process.
herbaceous plant	A plant without a woody stem.
homogeneity	Consistency in the environment over space and time.
HRSG	The abbreviation for heat recovery steam generation.
HSE	The abbreviation for health, safety and environment.
HSE-SD	The abbreviation for health, safety, environment and sustainable development.
HTFT	The abbreviation for high-temperature froth treatment.
humic	Organic material that is at an advanced stage of decomposition.

hydrocarbon	A compound consisting of only hydrogen and carbon. The simplest hydrocarbons are gases at ordinary temperatures. With increasing complexity of molecular structure they become liquids and solids. Natural gas and petroleum are mixes of hydrocarbons.
hydrogeology	The science dealing with the occurrence of surface and groundwater, its use, and its functions in modifying the earth, primarily by erosion and deposition.
hydrology	The science that treats the occurrence, circulation, distribution and properties of the waters of the earth, and their reaction with the environment.
ICS	The abbreviation for incident command system.
impact, environmental	The effect on the environment.
in situ	In the ground, undisturbed. In its original place.
INAC	The abbreviation for Indian and Northern Affairs Canada.
infrastructure	Basic facilities, such as transportation, communications, power supplies and buildings, which enable an organization, project or community to function.
interburden	Sand and clay material that is interbedded with the bitumen ore.
invertebrate	An animal without a backbone and internal skeleton.
iPMS	The abbreviation for integrated Project Management System.
IRC	The abbreviation for Industry Relations Corporation.
ISBL	The abbreviation for inside battery limit.
ISO	The abbreviation for International Organization for Standardization.
K	The metric symbol for kelvin.
key indicator resource	The environmental attributes or components identified as a result of a social scoping exercise as having legal, scientific, cultural, economic or aesthetic value.
kg	The metric symbol for kilogram.
km	The metric symbol for kilometre.
km^2	The metric symbol for square kilometre.
kPa	The metric symbol for kilopascal.

kV	The metric symbol for kilovolt.
L/d	The metric symbol for litres per day.
lake	A large sheet of standing water occupying a basin.
landform	The configuration of the ground surface as a factor in soil formation. It includes slope steepness and aspect as well as relief. Also, configurations of land surfaces taking distinctive forms and produced by natural processes (e.g., hill, valley, plateau).
LAS	The abbreviation for Log ASCII Standard.
Lease 13	The oil sands lease that Shell will mine for the Athabasca Oil Sands Project.
LFH	The abbreviation for litter-fibric-humic.
litter	The uppermost, slightly decayed layer of organic matter on the forest floor.
litter-fibric-humic	Forest floor that accumulates on the mineral soil surface under forest vegetation, and which includes dead vegetation and organic matter, including litter and unincorporated humus.
littoral zone	The zone in a lake that is closest to the shore. It includes the part of the lake bottom, and its overlying water, between the highest water level and the depth where there is enough light (about 1% of the surface light) for rooted aquatic plants and algae to colonize the bottom sediments.
LM	The abbreviation for Lower McMurray.
M	The metric symbol for million.
m	The metric symbol for metre.
m/s	The metric symbol for metres per second.
m^3	The metric symbol for cubic metres.
MAC	The abbreviation for Mining Association of Canada.
marsh	A mineral or peat-filled wetland that is periodically inundated by standing or slowly moving water.
masl	The abbreviation for metres above sea level.
mature fine tailings	Fine tailings that have dewatered to about 30% solids during the three years following deposition.
Mbbl	The abbreviation for million barrels.

MCFN	The abbreviation for Mikisew Cree First Nation.
merchantable timber	The coniferous and deciduous trees that are cut down during site clearing and that can be sold.
MFT	The abbreviation for mature fine tailings.
MICA	The abbreviation for Métis – Industry Consultation Agreement.
migration	Animals or birds changing their habitat, usually with the seasons.
mine pit	The excavated area of a mine.
mineral soil	A, B and C horizons and underlying parent material.
mitigation	The process of rectifying an impact by repairing, rehabilitating or restoring the affected environment, or the process of compensating for the impact by replacing or providing substitute resources or environments.
MJ	The metric symbol for megajoule.
ML	The metric symbol for million litres.
mm	The metric symbol for millimetre.
MM	The abbreviation for Middle McMurray.
MM1	The abbreviation for Middle McMurray 1.
MM2	The abbreviation for Middle McMurray 2.
Mm^3	The metric symbol for millions of cubic metres.
modelling	A simplified representation of a relationship or system of relationships. Modelling involves calculation techniques used to make quantitative estimates of an output parameter based on its relationship to input parameters. The input parameters influence the value of the output parameters.
monitoring	The process of measuring continuously, or at intervals, a condition that must be kept within set limits.
MOU	The abbreviation for memorandum of understanding.
movement corridors	Travel ways used by wildlife for daily, seasonal, annual or dispersal movements from one area or habitat to another.
MSI	The abbreviation for Municipal Sustainability Initiative.
MSL	The abbreviation for mineral surface lease.

Mt	The metric symbol for millions of tonnes.
Mt/a	The metric symbol for millions of tonnes per annum.
muskeg	A thick deposit of partially decayed vegetable matter of wet boreal regions.
MW	The metric symbol for megawatt.
N/A	The abbreviation for not applicable.
NAABA	The abbreviation for Northeastern Alberta Aboriginal Business Association.
ng/J	The metric symbol for nanograms per joule.
NLHR	The abbreviation for Northern Lights Health Region.
NO_2	The chemical formula for nitrogen dioxide.
NO_x	The chemical formula for oxides of nitrogen.
NPRI	The abbreviation for National Pollutant Release Inventory.
NPV	The abbreviation for net present value.
NSMWG	The abbreviation for the NO_x and SO_x Management Working Group.
NST	The abbreviation for non-segregating tailings.
NTU	The abbreviation for nephelometric turbidity unit.
nutrients	Environmental substances, such as nitrogen or phosphorous, that are necessary for the growth and development of plants and animals.
OBDA	The abbreviation for overburden disposal area.
oil sands	An unconsolidated, porous sand formation or sandstone containing or impregnated with petroleum or hydrocarbons.
OIP	The abbreviation for Operations Implementation Plan.
orebody	A solid and fairly continuous mass of ore, which may include low-grade ore and waste as well as pay ore, but is individualized by form or character from adjoining country rock.
organic horizon	Surface soil horizon in organic soils containing more than 17% organic carbon by weight.

organic soil	An order of soils that has developed dominantly from organic deposits. Most organic soils are saturated for most of the year, unless artificially drained, but some of them are not usually saturated for more than a few days. They contain 17% or more organic carbon.
OSCA	The abbreviation for *Oil Sands Conservation Act*.
OSDC	The abbreviation for Oil Sands Discovery Centre.
OSEC	The abbreviation for Oil Sands Environmental Coalition.
OSSA	The abbreviation for Oil Sands Safety Association.
OSVRC	The abbreviation for Oil Sands Vegetation Reclamation Committee.
OV	The abbreviation for overburden.
overburden	Material below the soil profile and above the bituminous sand.
PAC	The abbreviation for powdered activated carbon.
PAH	The abbreviation for polycyclic aromatic hydrocarbons.
paraffinic	Relating to hydrocarbons with the formula C_nH_{2n+2}.
parameter	A distinguishing or defining characteristic or feature, especially one that may be measured or quantified.
particulate matter	Particles with a mean diameter of less than 30 μm.
peat–mineral mixture	A mixture of an organic horizon and the underlying mineral soil, or an organic horizon and mineral soil from another source, where the mineral soil in both cases is rated as good, fair or poor.
perched water	Groundwater that is unconfined and separated from an underlying main body of groundwater by an unsaturated zone.
permeability	The ease with which gases or liquids penetrate or pass through a bulk mass of material, such as soil or sediments.
pesticide	A chemical agent that destroys pests. Also known as *biocide*.
pH	The measurement of a substance's acidity or alkalinity.
pilot plant	A small plant used for testing development processes under actual production conditions.

Planned Development Case	Includes the predicted impacts of the Jackpine Mine Expansion and the Pierre River Mine Project, plus the approved and publicly disclosed oil sands projects and planned oil sands projects in the region. In accordance with the *Canadian Environmental Assessment Act*, only residual impacts from the Application Case that were considered to have low to high environmental consequences were assessed in the Planned Development Case.
plant community	An association of plants of various species found growing together.
Pleistocene	Of, or relating to, the geological period that lasted from about two million years before present (BP) to 10,000 BP.
PM	The abbreviation for particulate matter.
$PM_{2.5}$	The abbreviation for fine particulate matter with a diameter smaller than 2.5 μm.
polishing pond	A water containment pond designed to remove suspended sediment from muskeg drainage, overburden dewatering, reclamation material storage area runoff and overburden disposal area runoff, before the waters are released to natural receiving streams. Also known as *sedimentation pond.*
polygon	The spatial area delineated on a map to define one feature unit, e.g., one type of ecosite phase.
porewater	Water between the grains of a soil or rock.
ppm	The abbreviation for parts per million.
pre-stripping	The process of removing overburden from the surface of the land in preparation for mining.
PRM	The abbreviation for Pierre River Mine.
PSC	The abbreviation for primary separation cell.
purging	The act of displacing the contents in a line or a piece of equipment by depressurizing and introducing an inert fluid, such as nitrogen.
RAMP	The acronym for Regional Aquatic Monitoring Program.
RARA	The abbreviation for Regional Aboriginal Recognition Awards.
RCMP	The abbreviation for Royal Canadian Mounted Police.
receptor	The person or organism subjected to chemical exposure.
reclamation	The process of returning disturbed land to a stable, biologically productive state.

reclamation certificate	A certificate issued by an AENV Conservation and Reclamation Inspector, signifying that the terms and conditions of a conservation and reclamation approval have been complied with.
reclamation plan	The detailed soil reconstruction and revegetation practices that are to be used for reclamation. Equivalent to the 10-year conservation and reclamation plan.
reconstruction	Selectively placing suitable overburden material on reshaped spoils.
recreation	An activity or pastime pursued, especially habitually, for the pleasure or interest it gives.
revegetation	Establishing vegetation to replace the original ground cover following land disturbance.
riparian	Areas near or relating to a river.
riprap	A foundation or revetment in water or on soft ground made of irregularly placed stones or pieces of boulders that is used chiefly for river and harbour work, for roadway filling and on embankments.
RIWG	The abbreviation for Regional Issues Working Group.
RMS	The abbreviation for reclamation material stockpile.
RMWB	The abbreviation for Regional Municipality of Wood Buffalo.
RSDS	The abbreviation for regional sustainable development strategy.
runoff	The portion of precipitation (rain and snow) that ultimately reaches streams via surface systems.
RWG	The abbreviation for Reclamation Working Group.
saline	Impregnated with, or containing, salt or salts.
SCR	The abbreviation for selective catalytic reduction.
sd	The abbreviation for stream day.
SEA	The abbreviation for south extension area.
sediment	A mass of organic or inorganic solid fragmented material, or the solid fragment itself, that comes from the weathering of rock and is carried by, suspended in, or dropped by air, water, or ice. Also, a mass that is accumulated by any other natural agent and that forms in layers on the earth's surface, such as sand, gravel, silt, mud, fill or loess.

sedimentation pond	A water containment pond designed to remove suspended sediment from muskeg drainage, overburden dewatering, reclamation material storage area runoff and overburden disposal area runoff, before the waters are released to natural receiving streams. Also known as *polishing pond.*
seepage	The slow movement of water or other fluids through a process medium, or through small openings in the surface of unsaturated soil.
SEIA	The abbreviation for Socio-Economic Impact Assessment.
SEWG	The abbreviation for Sustainable Ecosystem Working Group.
Shell	The abbreviation for Shell Canada Limited.
silt	Fine sand, clay or other soil carried by moving or running water and deposited as sediment on the bottom or on the shore of a lake or stream.
slurry	A free-flowing, pumpable suspension of fine solid material in liquid.
SO_2	The chemical formula for sulphur dioxide.
soil	Naturally occurring, unconsolidated mineral or organic material, at least 10 cm thick, that occurs at the earth's surface and is capable of supporting plant growth.
soil capability	An evaluation of soil performance that focuses on the degree and nature of limitation imposed by the physical characteristics of the soil unit on a certain use, such as agriculture, forestry or recreation.
SO_x	The chemical formula for oxides of sulphur.
species	A group of organisms that actually or potentially interbreed and are reproductively isolated from all other such groups; a taxonomic grouping of genetically and morphologically similar individuals; the category below genus.
SRC	The abbreviation for Saskatchewan Research Council.
SRU	The abbreviation for solvent recovery unit.
stack	The vertical chimney-like installation that is the waste disposal system for unwanted vapour, such as flue gases.
stakeholders	People or organizations with an interest or share in an undertaking, such as a commercial venture.
stockpile	A gradually accumulated reserve of material.

subsoil A stratum that includes one or more of the following:

- that portion of the B horizon left after salvage of upland surface soil
- the C horizon of an upland soil
- underlying parent material at an upland location that is rated as good, fair or poor
- mineral material below an organic layer at a location other than upland, that is rated as good, fair or poor

succession A series of dynamic changes by which one group of organisms succeeds another through stages leading to a climax community.

Suncor The abbreviation for Suncor Energy Inc.

swamp A peat-filled area or a mineral wetland with standing or gently flowing water occurring in pools and channels.

SWWG The abbreviation for Surface Water Working Group.

Syncrude The abbreviation for Syncrude Canada Ltd.

t The metric symbol for tonne.

t/h The metric symbol for tonnes per hour.

tailings A by-product of oil sands extraction comprising water, coarse sand, fine minerals and minor amounts of rejected bitumen waste.

tainting, fish Fish contamination.

TDG The abbreviation for transportation of dangerous goods.

TEK The abbreviation for traditional environmental knowledge.

terrestrial Of or on or relating to the earth.

TFT The abbreviation for thin fine tailings.

thalweg The line of the fastest descent from any point on land, especially one connecting the deepest points along a river channel or the lowest points along a valley floor.

till Unsorted sedimentary material deposited directly by and underneath a glacier, consisting of a mixture of clay, silt, sand, gravel and boulders. Also known as *glacial deposit.*

timber Trees in their natural state, not considered as building material.

TMAC WG The abbreviation for Trace Metals and Air Contaminants Working Group.

topography	The shape of the ground surface, such as hills, mountains or plains.
topsoil	The uppermost layer of soil having a good, fair or poor rating as described in Alberta Agriculture's *Soil Quality Criteria Relative to Disturbance and Reclamation*.
TOR	The abbreviation for Terms of Reference.
toxic	A substance, dose or concentration that is harmful to a living organism.
toxicity	The inherent potential or capacity of a material to cause adverse effects in a living organism.
trace metal	A metal present in trace amounts.
trafficable	Describing the ground surface when it is able to support vehicular traffic.
trapping	Catching wild animals in traps.
TSM	The abbreviation for towards sustainable mining.
TSRU	The abbreviation for tailings solvent recovery unit.
TSS	The abbreviation for total suspended solids.
TT	The abbreviation for thickened tailings.
TV/BIP	The abbreviation for total volume to bitumen in place.
UM	The abbreviation for Upper McMurray.
ungulate	An animal that has hoofs.
upland	High or hilly country.
upland soil	Mineral soil developed on mineral parent material under forests in locations with imperfect drainage or drier, typically including LFH and A, B and C horizons.
upland surface soil	A stratum salvaged from an upland soil that includes the LFH, A horizon and in some cases, part of the entire B horizon.
utility corridor	A right-of-way containing pipelines, power lines and road access.
vapour recovery	The process of capturing and recycling process water vapour in a closed-circuit system.
vegetation	Plant life.
VOC	The abbreviation for volatile organic compound.

waste (mining)	All solids, liquids and sludge produced in the course of constructing, operating and abandoning facilities.
waterbody	A natural geographical feature containing water, such as a lake or a stream.
watercourse	A brook, stream or artificial water channel.
watershed	The entire surface drainage area that contributes water to a lake or river.
WBEA	The abbreviation for Wood Buffalo Environmental Association.
WESP	The abbreviation for wet electrostatic precipitator.
wetlands	Land having the water table at, near, or above the land surface, or which is saturated for long enough periods to promote wetland or aquatic processes as indicated by biological activity adapted to the wet environment.
wt%	The abbreviation for weight percent.
zeolite	Each of a number of minerals consisting mainly of hydrous silicates of calcium, sodium and aluminum, able to act as cation exchangers.