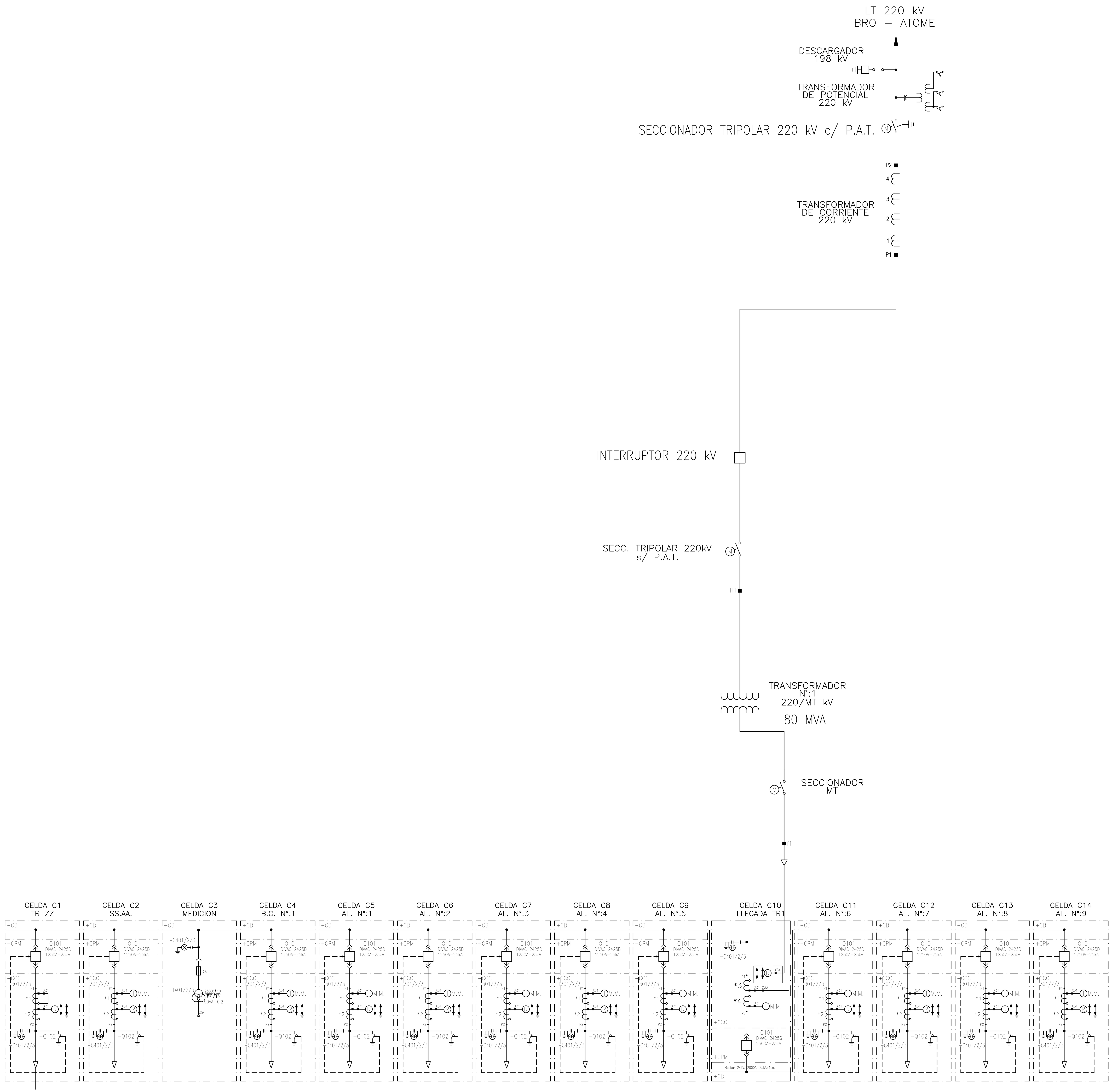
ANNEXES

Annex 1 – Substation General Arrangement Plant and Unifiliar Diagrams



REV.	FECHA	NOMBRE	DESCRIPCION	APROBO	FECHA
2					
1					
–	08/2022	W.S.	PRELIMINAR		

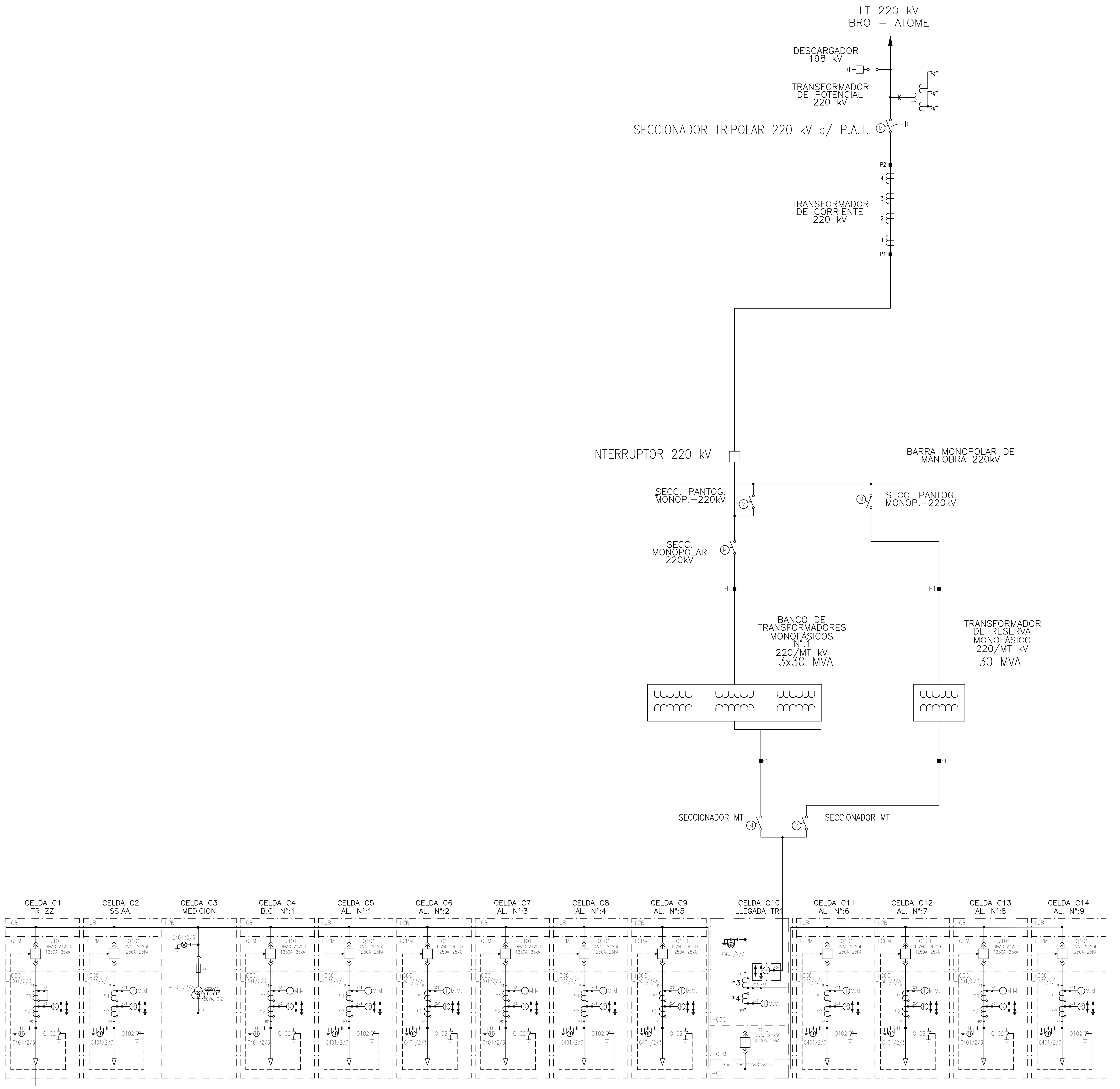
ATOME

ATOME PARAGUAY S.A.
ATOME ENERGY PLC

CONCRET MIX S.A.

"CONSTRUCCIÓN DE LA SUBESTACIÓN ATOME"

PROY.	Ing. W. Sora		SUBESTACION ATOME DIAGRAMA UNIFILAR – TRAFO TRIFÁSICO 1 x 80 MVA
REVISO	Ing. S. Semidei		
APROBO	Ing. H. Richer		Esc.:S/E — CÓDIGO DE PLANO



2					
1					
–	08/2022	W.S.	PRELIMINAR		
REV.	FECHA	NOMBRE	DESCRIPCION	APROBO	FECHA

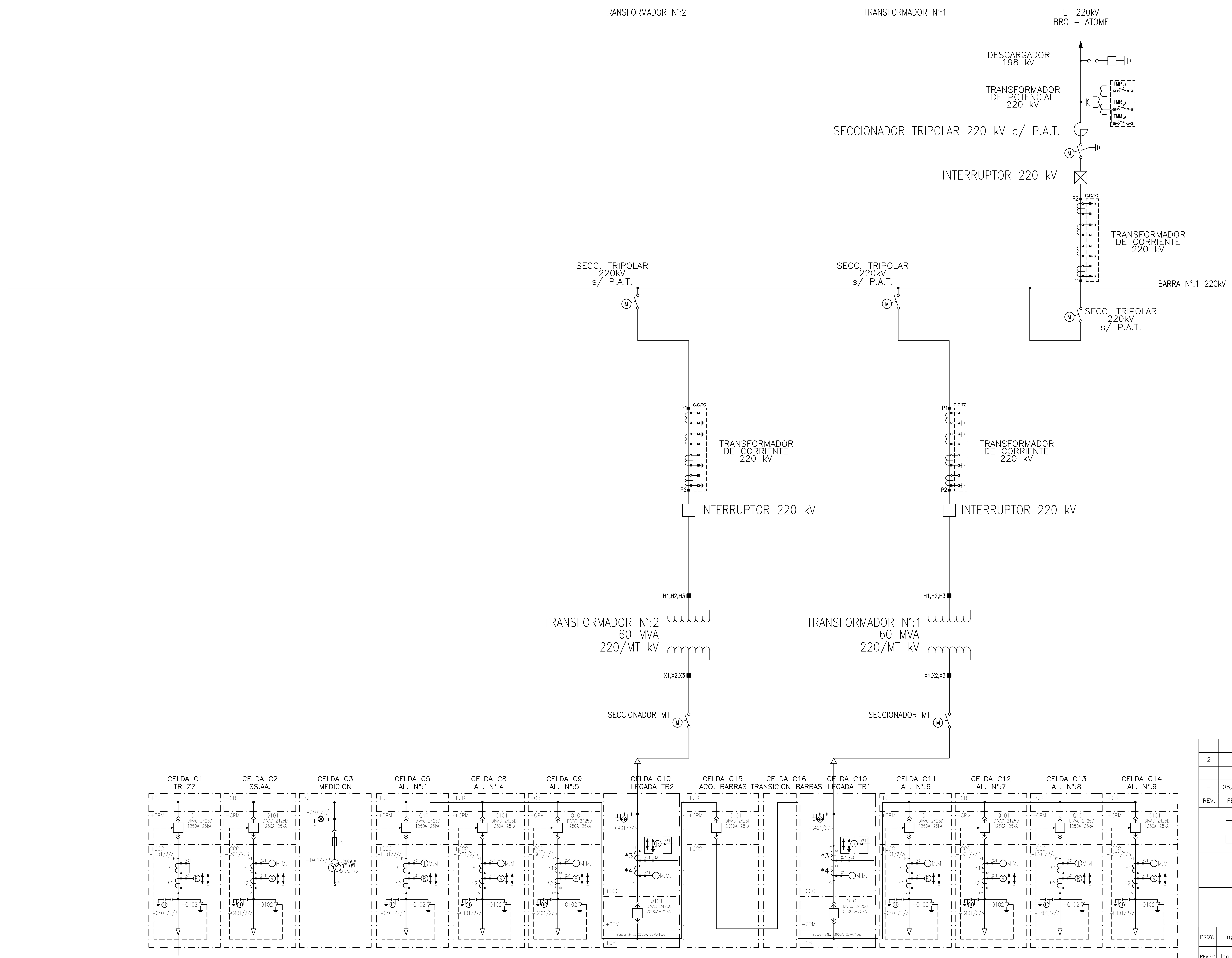
ATOME

ATOME PARAGUAY S.A.
ATOME ENERGY PLC

CONCRET MIX S.A.

"CONSTRUCCIÓN DE LA SUBESTACIÓN ATOME"

PROY.	Ing. W. Sora		SUBESTACION ATOME DIAGRAMA UNIFILAR BANCO DE TRAFOS 4 x 30 MVA
REVISO	Ing. S. Semidei		
APROBO	Ing. H. Richer		Esc.:S/E — CÓDIGO DE PLANO



2					
1					
–	08/2022	W.S.	PRELIMINAR		
REV.	FECHA	NOMBRE	DESCRIPCION	APROBO	FECHA

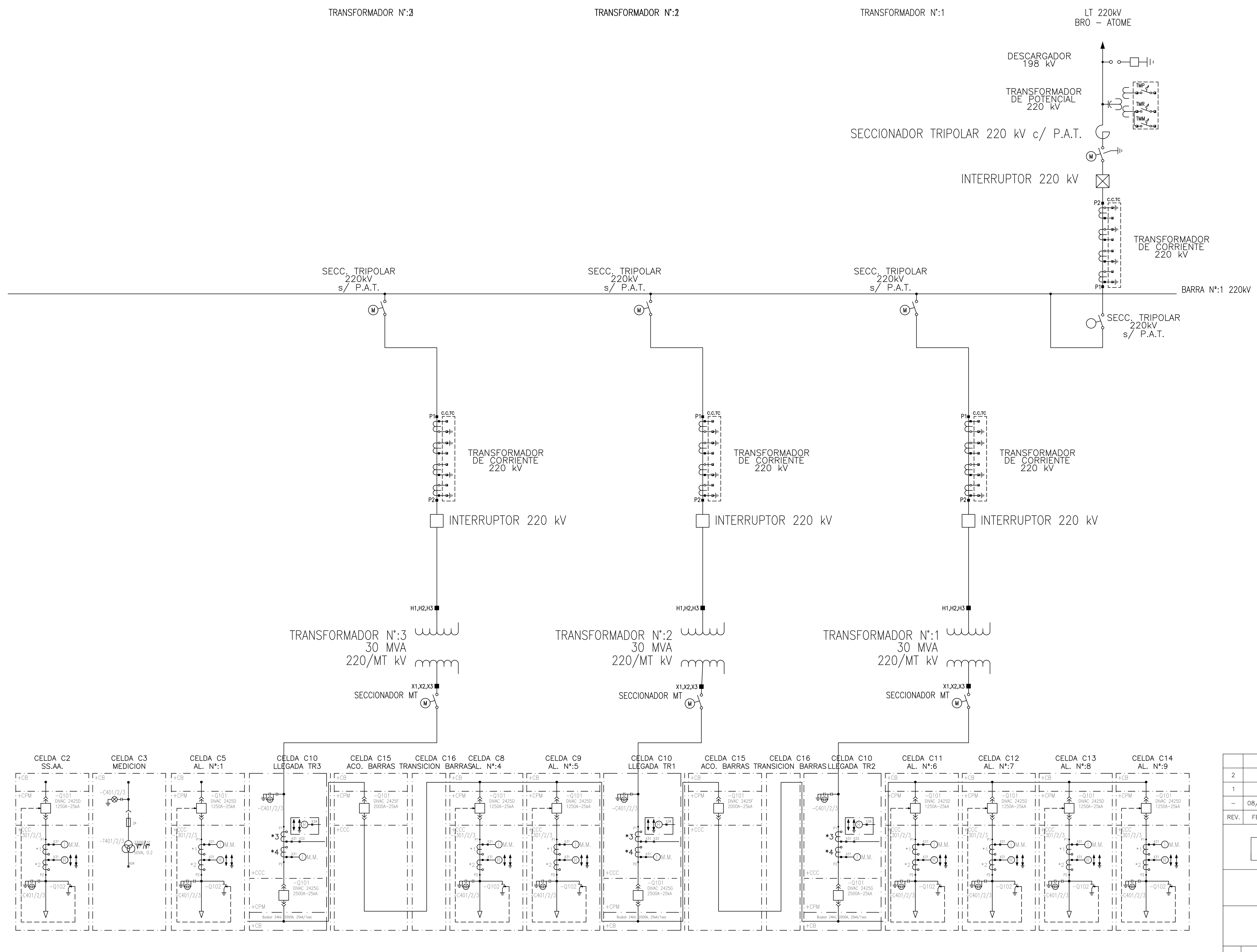
ATOME

ATOME PARAGUAY S.A.
ATOME ENERGY PLC

CONCRET MIX S.A.

"CONSTRUCCIÓN DE LA SUBESTACIÓN ATOME"

PROY.	Ing. W. Sora		SUBESTACION ATOME DIAGRAMA UNIFILAR – TRAFOS TRIFÁSICOS 2 x 60 MVA
REVISO	Ing. S. Semidei		
APROBO	Ing. H. Richer	Esc.:S/E	CÓDIGO DE PLANO



2					
1					
–	08/2022	W.S.	PRELIMINAR		
REV.	FECHA	NOMBRE	DESCRIPCION	APROBO	FECHA

ATOME

ATOME PARAGUAY S.A.
ATOME ENERGY PLC

CONCRET MIX S.A.

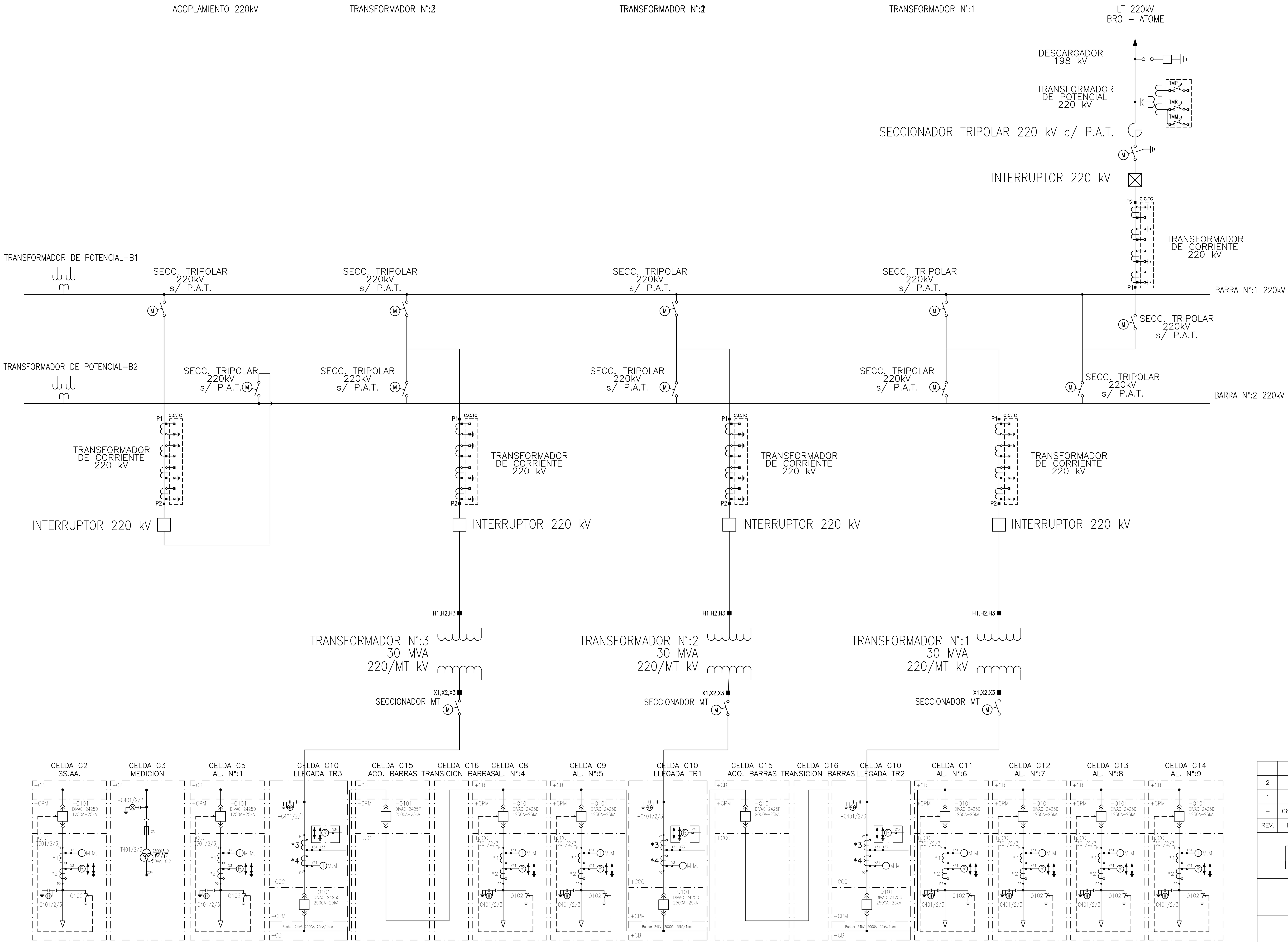
"CONSTRUCCIÓN DE LA SUBESTACIÓN ATOME"

PROY.	Ing. W. Sora	
REVISO	Ing. S. Semidei	
APROBO	Ing. H. Richer	

SUBESTACION ATOME
DIAGRAMA UNIFILAR – TRAFOS TRIFÁSICOS 3 x 30 MVA
BARRA SIMPLE

Esc.: S/E

CÓDIGO DE PLANO



2					
1					
–	08/2022	W.S.	PRELIMINAR		
REV.	FECHA	NOMBRE	DESCRIPCION	APROBO	FECHA

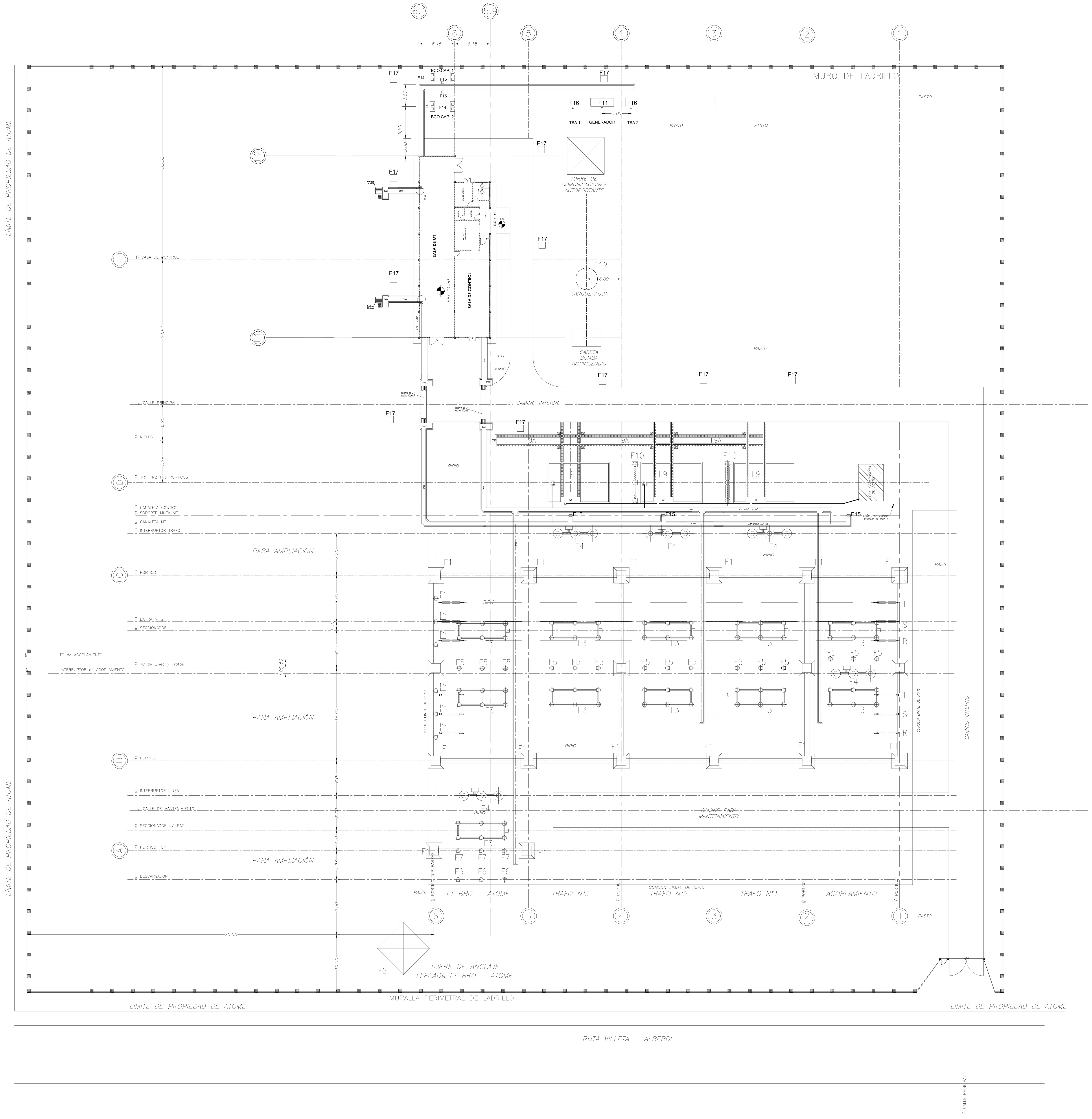
ATOME

ATOME PARAGUAY S.A.
ATOME ENERGY PLC

CONCRET MIX S.A.

"CONSTRUCCIÓN DE LA SUBESTACIÓN ATOME"

PROY.	Ing. W. Sora		SUBESTACION ATOME DIAGRAMA UNIFILAR – TRAFOS TRIFÁSICOS 3 x 30 MVA DOBLE BARRA
REVISO	Ing. S. Semidei		
APROBO	Ing. H. Richer		Esc.:S/E — CÓDIGO DE PLANO



SIMBOLOGIA

E.T.N ELEVACION TERRENO NATURAL
CC40 CANALETA DE 0,40M
CC60 CANALETA DE 0,60M
CC80 CANALETA DE 0,80M
CC100 CANALETA DE 1,0M
CA60 CAMARA 1,40 X 1,20M
CA80 CAMARA 2,0 X 1,0M

CABRESTANTE 1 EN CABECERA VIGA DE TRANSFORMADOR
CABRESTANTE 2 EN CABECERA VIGA DE RIEL AUXILIAR
CABRESTANTE 3 CABRESTANTE AISLADO EN FRENTE DE TRANSFORMADORES

H°A° HORMIGON ARMADO
H°S° HORMIGON SIMPLE.
COTA DE NIVEL

1 A EJES PRINCIPALES DE LA ESTACION

REV.	FECHA	NOMBRE	DESCRIPCION	APROBO	FECHA
2					
1					
–	09/2022	W.S.	PRELIMINAR		

ATOME

ATOME PARAGUAY S.A.
ATOME ENERGY PLC

CONCRET MIX S.A.

"CONSTRUCCIÓN DE LA SUBESTACIÓN ATOME"

PROY.	Ing. W. Sora	SUBESTACION ATOME DISPOSICIÓN GENERAL – PROPUESTA TRAFOS TRIFÁSICOS 3 x 30 MVA DOBLE BARRA
REVISO	Ing. S. Semidei	
APROBO	Ing. H. Richer	Esc.: 1/400 — CÓDIGO DE PLANO

Annex 2 – Water Quality Analysis Reports

GRUPO MULTILAB

Mcal. Estigarribia 1349 - Asunción, Paraguay
Tel. (595 21) 230 560 R.A.
www.multilab.com.py

EcoNatura
Laboratorio de Control
de Alimentos y Medio Ambiente

Informe de Resultados No. 1-0530/23

Determinación solicitada	Matriz
Análisis fisicoquímicos **Elementos químicos**	Agua de río

*Datos del cliente**	*Datos de la muestra*
Solicitado por: Sra. Renata Moretti **Empresa**: JGP CONSULTORÍA E PARTICIPAÇÕES LTDA **Dirección:** Rua Américo Brasiliense 615, Chácara Santo Antonio – São Paulo/SP – CEP: 04715-003. Brasil **Muestra identificada como:** AGUA DE RIO PY 1 – ARRIBA	**Código interno de EcoNatura**: 1-27961 **Fecha de recolección:** 21/03/2023 **Recolectado por:** Téc. Carlos Ruiz / Téc. Genaro Cañiza – Grupo Multilab S.A. **Descripción de la muestra:** La muestra fue recolectada por personal de Grupo Multilab S.A. en 2 (dos) botellas de vidrio ámbar y 1 (una) botella de plástico conteniendo aproximadamente 1 (un) litro cada una.
Fecha de inicio del análisis: 22/03/2023 **Fecha de finalización del análisis:** 21/04/2023	

*El Laboratorio es responsable de la información suministrada en el informe, excepto cuando la misma es proporcionada por el cliente.

Resultados

Análisis	Resultados	Valores de referencia*
pH Método: Potenciométrico	6,85	6,00 a 9,00
Turbidez Método: Nefelométrico ORBECO HELLIGE	14 NTU	100 NTU
Cloruros Método Espectrofotométrico: 90 LOVIBOND	3 mg/L Cl^-	SR**
Sulfatos Método Espectrofotométrico: 360 LOVIBOND	< 2 mg/L SO_4^{-2}	250 mg/L SO_4^{-2}
Amonio no ionizable Método Espectrofotométrico: 62 LOVIBOND	0,02 mg/L NH_3	0,02 mg/L NH_3
Nitrato Método Espectrofotométrico: 8039 HACH	0,5 mg/L N	10 mg/L N

Informe de Resultados No. 1-0530/23

Nitrito Método Espectrofotométrico: 8507 HACH	0,002 mg/L N	1 mg/L N
Color Método Espectrofotométrico: 203 ORBECO HELLIGE	**90 mg/L Pt-Co**	75 mg/L Pt-Co
DBO (5 días, 20°C) Método: SM 5210 B	4,7 mg/L O_2	5 mg/L
Oxígeno disuelto Método: Medidor de oxígeno disuelto ORION STAR A223/RDO	**1,46 mg/L O_2**	No inferior a 5 mg/L O_2
Nitrógeno total Método Espectrofotométrico: 10071 HACH	**1,2 mg/L N**	0,6 mg/L N
Sólidos totales disueltos Método: APHA 2540 C	77 mg/L	500 mg/L
Cianatos Método: APHA 4500 – CN L	< 0,2 mg/L	0,2 mg/L
Cromo hexavalente Método Espectrofotométrico: 124 LOVIBOND	0,061 mg/L	0,5 mg/L
Cromo trivalente Método Espectrofotométrico: 124 LOVIBOND	< 0,005 mg/L	2 mg/L
Bifenilos Policlorados (PCB)*** Método: GC/MS	< 0,0002 mg/L	SR**
Dureza cálcica Método: Titulométrico	23 mg/L $CaCO_3$	300 mg/L $CaCO_3$

Informe de Resultados No. 1-0530/23

Materia Flotante Método: NMX-AA-006-SCFI-2000	Ausencia	Ausencia
Aceites y grasas Método: SM 5520 B	9 mg/L	Ausencia
Pesticidas		
Endosulfan I y II Método: GC/MS Límite de cuantificación: 0,010 mg/L	< 0,010 mg/L	0,056 mg/L
Diazinon Método: GC/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,005 mg/L
4,4 DDT Método: GC/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	0,002 mg/L
Endrin Método: GC/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,002 mg/L
Elementos químicos		
Aluminio (Al) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	**2,60 mg/L**	0,2 mg/L
Hierro soluble (Fe) Método: ICP/MS Límite de cuantificación: 0,1 mg/L	**2,1 mg/L**	0,3 mg/L
Sodio (Na) Método: ICP/MS Límite de cuantificación: 1 mg/L	5 mg/L	200 mg/L

Informe de Resultados No. 1-0530/23

Selenio (Se) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,01 mg/L
Manganeso (Mn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	**0,32 mg/L**	0,1 mg/L
Bario (Ba) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	0,07 mg/L	2 mg/L
Arsénico (As) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	0,003 mg/L	0,01 mg/L
Plomo (Pb) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	0,001 mg/L	0,01 mg/L
Cadmio (Cd) Método: ICP/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	0,001 mg/L
Cobre (Cu) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	1 mg/L
Estaño (Sn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	2 mg/L
Mercurio total (Hg) Método: ICP/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	SR**
Níquel (Ni) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	0,001 mg/L	0,025 mg/L
Zinc (Zn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	3 mg/L

Informe de Resultados No. 1-0530/23

Fósforo total (P) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	**0,37 mg/L**	0,050 mg/L

Observaciones: Los resultados obtenidos sólo afectan a la muestra recolectada y analizada en EcoNatura, un laboratorio del Grupo Multilab S.A.

*Referencia tomada de la Resolución Nº 222/02 emitida por la Secretaria del Medio Ambiente, por la cual se establece el padrón de calidad de las aguas en el territorio nacional. Clase 2. Art. 3º.

**SR: Sin Referencia

***Bifenilos Policlorados monitoreados: PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 y PCB 180.

Comentarios: No se registran.

Analizado por:	Autorizado por:
Viviana Báez Bioquímica Responsable del Laboratorio de Medio Ambiente	PA **Alicia Salgueiro** Bioquímica - Reg. Prof. Nº 1898 Director Técnico

Fecha y Hora del Informe: 24/04/2023; 11:26 h
Fin del informe.

Informe de Resultados No. 1-0531/23

Determinación solicitada	Matriz
Análisis fisicoquímicos **Elementos químicos**	Agua de río

*Datos del cliente**	*Datos de la muestra*
Solicitado por: Sra. Renata Moretti **Empresa**: JGP CONSULTORÍA E PARTICIPAÇÕES LTDA **Dirección:** Rua Américo Brasiliense 615, Chácara Santo Antonio – São Paulo/SP – CEP: 04715-003. Brasil **Muestra identificada como:** AGUA DE RIO PY 2 – PUNTO MEDIO	**Código interno de EcoNatura**: 1-27962 **Fecha de recolección:** 21/03/2023 **Recolectado por:** Téc. Carlos Ruiz / Téc. Genaro Cañiza – Grupo Multilab S.A. **Descripción de la muestra:** La muestra fue recolectada por personal de Grupo Multilab S.A. en 2 (dos) botellas de vidrio ámbar y 1 (una) botella de plástico conteniendo aproximadamente 1 (un) litro cada una.
Fecha de inicio del análisis: 22/03/2023 **Fecha de finalización del análisis:** 21/04/2023	

*El Laboratorio es responsable de la información suministrada en el informe, excepto cuando la misma es proporcionada por el cliente.

Resultados

Análisis	Resultados	Valores de referencia*
pH Método: Potenciométrico	6,77	6,00 a 9,00
Turbidez Método: Nefelométrico ORBECO HELLIGE	15 NTU	100 NTU
Cloruros Método Espectrofotométrico: 90 LOVIBOND	3 mg/L Cl^-	SR**
Sulfatos Método Espectrofotométrico: 360 LOVIBOND	< 2 mg/L SO_4^{-2}	250 mg/L SO_4^{-2}
Amonio no ionizable Método Espectrofotométrico: 62 LOVIBOND	0,01 mg/L NH_3	0,02 mg/L NH_3
Nitrato Método Espectrofotométrico: 8039 HACH	< 0,3 mg/L N	10 mg/L N

Informe de Resultados No. 1-0531/23

Nitrito Método Espectrofotométrico: 8507 HACH	< 0,002 mg/L N	1 mg/L N
Color Método Espectrofotométrico: 203 ORBECO HELLIGE	**93 mg/L Pt-Co**	75 mg/L Pt-Co
DBO (5 días, 20°C) Método: SM 5210 B	3,9 mg/L O_2	5 mg/L
Oxígeno disuelto Método: Medidor de oxígeno disuelto ORION STAR A223/RDO	**1,62 mg/L O_2**	No inferior a 5 mg/L O_2
Nitrógeno total Método Espectrofotométrico: 10071 HACH	**1,6 mg/L N**	0,6 mg/L N
Sólidos totales disueltos Método: APHA 2540 C	70 mg/L	500 mg/L
Cianatos Método: APHA 4500 – CN L	< 0,2 mg/L	0,2 mg/L
Cromo hexavalente Método Espectrofotométrico: 124 LOVIBOND	0,059 mg/L	0,5 mg/L
Cromo trivalente Método Espectrofotométrico: 124 LOVIBOND	< 0,005 mg/L	2 mg/L
Bifenilos Policlorados (PCB)*** Método: GC/MS	< 0,0002 mg/L	SR**
Dureza cálcica Método: Titulométrico	39 mg/L $CaCO_3$	300 mg/L $CaCO_3$

Informe de Resultados No. 1-0531/23

Materia Flotante Método: NMX-AA-006-SCFI-2000	Ausencia	Ausencia
Aceites y grasas Método: SM 5520 B	9 mg/L	Ausencia
<u>Pesticidas</u>		
Endosulfan I y II Método: GC/MS Límite de cuantificación: 0,010 mg/L	< 0,010 mg/L	0,056 mg/L
Diazinon Método: GC/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,005 mg/L
4,4 DDT Método: GC/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	0,002 mg/L
Endrin Método: GC/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,002 mg/L
<u>Elementos químicos</u>		
Aluminio (Al) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	**1,92 mg/L**	0,2 mg/L
Hierro soluble (Fe) Método: ICP/MS Límite de cuantificación: 0,1 mg/L	**2,1 mg/L**	0,3 mg/L
Sodio (Na) Método: ICP/MS Límite de cuantificación: 1 mg/L	5 mg/L	200 mg/L

Informe de Resultados No. 1-0531/23

Selenio (Se) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,01 mg/L
Manganeso (Mn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	**0,32 mg/L**	0,1 mg/L
Bario (Ba) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	0,07 mg/L	2 mg/L
Arsénico (As) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	0,003 mg/L	0,01 mg/L
Plomo (Pb) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,01 mg/L
Cadmio (Cd) Método: ICP/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	0,001 mg/L
Cobre (Cu) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	1 mg/L
Estaño (Sn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	2 mg/L
Mercurio total (Hg) Método: ICP/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	SR**
Níquel (Ni) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	0,001 mg/L	0,025 mg/L
Zinc (Zn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	3 mg/L

Informe de Resultados No. 1-0531/23

Fósforo total (P) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	**0,34 mg/L**	0,050 mg/L

Observaciones: Los resultados obtenidos sólo afectan a la muestra recolectada y analizada en EcoNatura, un laboratorio del Grupo Multilab S.A.

*Referencia tomada de la Resolución Nº 222/02 emitida por la Secretaria del Medio Ambiente, por la cual se establece el padrón de calidad de las aguas en el territorio nacional. Clase 2. Art. 3º.

**SR: Sin Referencia

***Bifenilos Policlorados monitoreados: PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 y PCB 180.

Comentarios: No se registran.

Analizado por:	Autorizado por:
Viviana Báez Bioquímica Responsable del Laboratorio de Medio Ambiente	PA **Alicia Salgueiro** Bioquímica - Reg. Prof. No. 1898. Director Técnico

EcoNatura Laboratorio de Control de Alimentos y Medio Ambiente

Fecha y Hora del Informe: 24/04/2023; 11:30 h
Fin del informe.

Informe de Resultados No. 1-0532/23

Determinación solicitada	Matriz
Análisis fisicoquímicos **Elementos químicos**	Agua de río

*Datos del cliente**	*Datos de la muestra*
Solicitado por: Sra. Renata Moretti **Empresa**: JGP CONSULTORÍA E PARTICIPAÇÕES LTDA **Dirección:** Rua Américo Brasiliense 615, Chácara Santo Antonio – São Paulo/SP – CEP: 04715-003. Brasil **Muestra identificada como:** AGUA DE RIO PY 3 – ABAJO	**Código interno de EcoNatura**: 1-27963 **Fecha de recolección:** 21/03/2023 **Recolectado por:** Téc. Carlos Ruiz / Téc. Genaro Cañiza – Grupo Multilab S.A. **Descripción de la muestra:** La muestra fue recolectada por personal de Grupo Multilab S.A. en 2 (dos) botellas de vidrio ámbar y 1 (una) botella de plástico conteniendo aproximadamente 1 (un) litro cada una.
Fecha de inicio del análisis: 22/03/2023 **Fecha de finalización del análisis:** 21/04/2023	

*El Laboratorio es responsable de la información suministrada en el informe, excepto cuando la misma es proporcionada por el cliente.

Resultados

Análisis	Resultados	Valores de referencia*
pH Método: Potenciométrico	6,75	6,00 a 9,00
Turbidez Método: Nefelométrico ORBECO HELLIGE	13 NTU	100 NTU
Cloruros Método Espectrofotométrico: 90 LOVIBOND	3 mg/L Cl^-	SR**
Sulfatos Método Espectrofotométrico: 360 LOVIBOND	< 2 mg/L SO_4^{-2}	250 mg/L SO_4^{-2}
Amonio no ionizable Método Espectrofotométrico: 62 LOVIBOND	0,01 mg/L NH_3	0,02 mg/L NH_3
Nitrato Método Espectrofotométrico: 8039 HACH	< 0,3 mg/L N	10 mg/L N

Informe de Resultados No. 1-0532/23

Nitrito Método Espectrofotométrico: 8507 HACH	< 0,002 mg/L N	1 mg/L N
Color Método Espectrofotométrico: 203 ORBECO HELLIGE	**91 mg/L Pt-Co**	75 mg/L Pt-Co
DBO (5 días, 20°C) Método: SM 5210 B	3,9 mg/L O_2	5 mg/L
Oxígeno disuelto Método: Medidor de oxígeno disuelto ORION STAR A223/RDO	**1,33 mg/L O_2**	No inferior a 5 mg/L O_2
Nitrógeno total Método Espectrofotométrico: 10071 HACH	**1,3 mg/L N**	0,6 mg/L N
Sólidos totales disueltos Método: APHA 2540 C	73 mg/L	500 mg/L
Cianatos Método: APHA 4500 – CN L	< 0,2 mg/L	0,2 mg/L
Cromo hexavalente Método Espectrofotométrico: 124 LOVIBOND	0,058 mg/L	0,5 mg/L
Cromo trivalente Método Espectrofotométrico: 124 LOVIBOND	< 0,005 mg/L	2 mg/L
Bifenilos Policlorados (PCB)*** Método: GC/MS	< 0,0002 mg/L	SR**
Dureza cálcica Método: Titulométrico	35 mg/L $CaCO_3$	300 mg/L $CaCO_3$

Informe de Resultados No. 1-0532/23

Materia Flotante Método: NMX-AA-006-SCFI-2000	Ausencia	Ausencia
Aceites y grasas Método: SM 5520 B	8 mg/L	Ausencia
Pesticidas		
Endosulfan I y II Método: GC/MS Límite de cuantificación: 0,010 mg/L	< 0,010 mg/L	0,056 mg/L
Diazinon Método: GC/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,005 mg/L
4,4 DDT Método: GC/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	0,002 mg/L
Endrin Método: GC/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,002 mg/L
Elementos químicos		
Aluminio (Al) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	**2,43 mg/L**	0,2 mg/L
Hierro soluble (Fe) Método: ICP/MS Límite de cuantificación: 0,1 mg/L	**2,1 mg/L**	0,3 mg/L
Sodio (Na) Método: ICP/MS Límite de cuantificación: 1 mg/L	5 mg/L	200 mg/L

Informe de Resultados No. 1-0532/23

Selenio (Se) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,01 mg/L
Manganeso (Mn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	**0,30 mg/L**	0,1 mg/L
Bario (Ba) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	0,07 mg/L	2 mg/L
Arsénico (As) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	0,003 mg/L	0,01 mg/L
Plomo (Pb) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,01 mg/L
Cadmio (Cd) Método: ICP/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	0,001 mg/L
Cobre (Cu) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	1 mg/L
Estaño (Sn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	2 mg/L
Mercurio total (Hg) Método: ICP/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	SR**
Níquel (Ni) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	0,001 mg/L	0,025 mg/L
Zinc (Zn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	3 mg/L

Informe de Resultados No. 1-0532/23

Fósforo total (P) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	**0,34 mg/L**	0,050 mg/L

Observaciones: Los resultados obtenidos sólo afectan a la muestra recolectada y analizada en EcoNatura, un laboratorio del Grupo Multilab S.A.

*Referencia tomada de la Resolución Nº 222/02 emitida por la Secretaria del Medio Ambiente, por la cual se establece el padrón de calidad de las aguas en el territorio nacional. Clase 2. Art. 3º.

**SR: Sin Referencia

***Bifenilos Policlorados monitoreados: PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 y PCB 180.

Comentarios: No se registran.

Analizado por:	Autorizado por:
Viviana Báez Bioquímica Responsable del Laboratorio de Medio Ambiente	PA **Alicia Salgueiro** Bioquímica - Reg. Prof. No. 1898 Director Técnico EcoNatura Laboratorio de Control de Alimentos y Medio Ambiente

Fecha y Hora del Informe: 24/04/2023; 11:35 h
Fin del informe.

Informe de Resultados Nº 781/23

Determinación Solicitada: Análisis Microbiológico según Art. Nº 7 de la Resolución 222/02 de la SEAM.	**Matriz:** Agua de Rio.
Solicitado por: JGP CONSULTORIA E PARTICIPAÇÕES LTDA.	**Dirección:** Rua Américo Brasiliense, 615, Chácara San Antonio, São Paulo /SP-CEP: 04715-003, Brasil.

Datos de la muestra

Identificación de la muestra: Agua de Rio - 781/23.

Nombre del Producto: Agua de Rio Py 1 – Arriba.

Contenido: Agua de Rio.

Presentación: Frasco estéril.

No. de Lote: N/A.

Vencimiento/Fecha de elaboración: N/A.

Cantidad de muestra: 2 frascos x 80mL.

Fecha y Hora de Recolección de la muestra: 21/03/2023; 10:40 h.

Fecha y Hora de Recepción de la muestra: 21/03/2023; 15:29 h.

Muestra recolectada por: Téc. Carlos Ruiz y Téc. Genaro Cañiza.

Descripción del punto de muestreo: La muestra se tomó con el muestreador a 150 mts. aproximadamente de la costa. Temperatura de muestreo: 31,1ºC.

Descripción de la muestra: Apariencia turbia. Temperatura de recepción: 10ºC.

Código interno: 3-11.114.

Metodología Analítica:

_*Coliformes Fecales o Termotolerantes, Coliformes Totales:* Técnica NMP/100mL (Número más probable): Caldo Lactosado. Temperatura de Incubación: 35°C - 37 °C. Tiempo de Incubación: 24 - 48 h. Caldo *E. coli*. Temperatura de Incubación: 44°C. Tiempo de incubación: 24 h.

Fecha de inicio del Análisis: 23/03/2023

Fecha de finalización del Análisis: 25/03/2023

Ensayos	Especificaciones*	Resultados
Coliformes Totales	Informativo	54200 NMP/100mL
Coliformes Fecales	4000 NMP/100mL	542 NMP/100mL

*Referencia tomada de la Resolución Nº 222/02 – Artículo 7 de la Secretaría del Ambiente.

Observaciones Generales: Los resultados obtenidos solo afectan a la muestra recepcionada y analizada en BioControl, un Laboratorio del Grupo Multilab S.A.

Comentarios: No se registran.

Analizado por:	Revisado y Autorizado por:
Lic. Biotec. Andrea Magali Planás Lugo Reg. Prof. Nº 055 **Analista**	Q.F. Grecia Doldán Reg. Prof. Nº. 1.657 **Director Técnico**

BioControl Microbiología Industrial

Fecha de Informe: 27/03/2023

Fin de Informe.

El laboratorio no es responsable de la información proporcionada por el cliente, que puede afectar la validez de los resultados.

GRUPO MULTILAB

Mcal. Estigarribia 1349 - Asunción, Paraguay
Tel. (595 21) 230 560 R.A.
www.multilab.com.py

BioControl
Microbiología Industrial

Informe de Resultados Nº 782/23

Determinación Solicitada: Análisis Microbiológico según Art. Nº 7 de la Resolución 222/02 de la SEAM.	**Matriz:** Agua de Rio.
Solicitado por: JGP CONSULTORIA E PARTICIPAÇÕES LTDA.	**Dirección:** Rua Américo Brasiliense, 615, Chácara San Antonio, São Paulo /SP-CEP: 04715-003, Brasil.

Datos de la muestra

Identificación de la muestra: Agua de Rio - 782/23.

Nombre del Producto: Agua de Rio Py 2 – Punto medio.

Contenido: Agua de Rio.

Presentación: Frasco estéril.

No. de Lote: N/A.

Vencimiento/Fecha de elaboración: N/A.

Cantidad de muestra: 2 frascos x 80mL.

Fecha y Hora de Recolección de la muestra: 21/03/2023; 11:00 h.

Fecha y Hora de Recepción de la muestra: 21/03/2023; 15:29 h.

Muestra recolectada por: Téc. Carlos Ruiz y Téc. Genaro Cañiza.

Descripción del punto de muestreo: La muestra se tomó con el muestreador a 100 mts. aproximadamente de la costa. Temperatura de muestreo: 32,1ºC.

Descripción de la muestra: Apariencia turbia. Temperatura de recepción: 9,2ºC.

Código interno: 3-11.115.

Metodología Analítica:

_*Coliformes Fecales o Termotolerantes, Coliformes Totales:* Técnica NMP/100mL (Número más probable): Caldo Lactosado. Temperatura de Incubación: 35°C - 37 °C. Tiempo de Incubación: 24 - 48 h. Caldo *E. coli*. Temperatura de Incubación: 44°C. Tiempo de incubación: 24 h.

Fecha de inicio del Análisis: 23/03/2023

Fecha de finalización del Análisis: 25/03/2023

Ensayos	Especificaciones*	Resultados
Coliformes Totales	Informativo	>240000 NMP/100mL
Coliformes Fecales	4000 NMP/100mL	1750 NMP/100mL

*Referencia tomada de la Resolución Nº 222/02 – Artículo 7 de la Secretaría del Ambiente.

Observaciones Generales: Los resultados obtenidos solo afectan a la muestra recepcionada y analizada en BioControl, un Laboratorio del Grupo Multilab S.A.

Comentarios: No se registran.

Analizado por:	Revisado y Autorizado por:
Lic. Biotec. Andrea Magali Planás Lugo Reg. Prof. Nº 055 **Analista**	Q.F. Grecia Doldán Reg. Prof. Nº. 1.657 **Director Técnico**

BioControl Microbiología Industrial

Fecha de Informe: 27/03/2023

Fin de Informe.

El laboratorio no es responsable de la información proporcionada por el cliente, que puede afectar la validez de los resultados.

Informe de Resultados Nº 783/23

Determinación Solicitada: Análisis Microbiológico según Art. Nº 7 de la Resolución 222/02 de la SEAM.	**Matriz:** Agua de Rio.
Solicitado por: JGP CONSULTORIA E PARTICIPAÇÕES LTDA.	**Dirección:** Rua Américo Brasiliense, 615, Chácara San Antonio, São Paulo /SP-CEP: 04715-003, Brasil.

Datos de la muestra

Identificación de la muestra: Agua de Rio - 783/23.

Nombre del Producto: Agua de Rio Py 3 – Abajo.

Contenido: Agua de Rio.

Presentación: Frasco estéril.

No. de Lote: N/A.

Vencimiento/Fecha de elaboración: N/A.

Cantidad de muestra: 2 frascos x 80mL.

Fecha y Hora de Recolección de la muestra: 21/03/2023; 11:20 h.

Fecha y Hora de Recepción de la muestra: 21/03/2023; 15:29 h.

Muestra recolectada por: Téc. Carlos Ruiz y Téc. Genaro Cañiza.

Descripción del punto de muestreo: La muestra se tomó con el muestreador a 100 mts. aproximadamente de la costa. Temperatura de muestreo: 31,4ºC.

Descripción de la muestra: Apariencia turbia. Temperatura de recepción: 9,4ºC.

Código interno: 3-11.116.

Metodología Analítica:

_*Coliformes Fecales o Termotolerantes, Coliformes Totales:* Técnica NMP/100mL (Número más probable): Caldo Lactosado. Temperatura de Incubación: 35°C - 37 °C. Tiempo de Incubación: 24 - 48 h. Caldo *E. coli*. Temperatura de incubación: 44°C. Tiempo de incubación: 24 h.

Fecha de inicio del Análisis: 23/03/2023

Fecha de finalización del Análisis: 25/03/2023

Ensayos	Especificaciones*	Resultados
Coliformes Totales	Informativo	24000 NMP/100mL
Coliformes Fecales	4000 NMP/100mL	700 NMP/100mL

*Referencia tomada de la Resolución Nº 222/02 – Artículo 7 de la Secretaría del Ambiente.

Observaciones Generales: Los resultados obtenidos solo afectan a la muestra recepcionada y analizada en BioControl, un Laboratorio del Grupo Multilab S.A.

Comentarios: No se registran.

Analizado por:	**Revisado y Autorizado por:**
Lic. Biotec. Andrea Magali Planás Lugo Reg. Prof. Nº 055 **Analista**	**Q.F. Grecia Doldán** Reg. Prof. Nº. 1.657 **Director Técnico**

BioControl Microbiología Industrial

Fecha de Informe: 27/03/2023

Fin de Informe.

El laboratorio no es responsable de la información proporcionada por el cliente, que puede afectar la validez de los resultados.

GRUPO MULTILAB

Mcal. Estigarribia 1349 - Asunción, Paraguay
Tel. (595 21) 230 560 R.A.
www.multilab.com.py

EcoNatura
Laboratorio de Control
de Alimentos y Medio Ambiente

Informe de Resultados No. 1-1611/23

Determinación solicitada	Matriz
Análisis fisicoquímicos **Elementos químicos**	Agua de río

*Datos del cliente**	*Datos de la muestra*
Solicitante: Sra. Renata Moretti – JGP CONSULTORÍA E PARTICIPAÇÕES LTDA **Dirección:** Villeta **Muestra identificada como:** AGUA DE RIO PY 1 – ARRIBA	**Código interno de EcoNatura**: 1-29042 **Fecha de recolección:** 14/06/2023 **Descripción de la muestra:** La muestra fue recolectada por personal de Grupo Multilab S.A. en 2 (dos) botellas de vidrio ámbar y 1 (una) botella de plástico conteniendo aproximadamente 1 (un) litro cada una.

Fecha de inicio del análisis: 14/06/2023
Fecha de finalización del análisis: 12/07/2023

*El Laboratorio es responsable de la información suministrada en el informe, excepto cuando la misma es proporcionada por el cliente.

Resultados

Análisis	Resultados	Valores de referencia**
pH Método: Potenciométrico	7,88	6,00 a 9,00
Turbidez Método: Nefelométrico ORBECO HELLIGE	10 NTU	100 NTU
Cloruros Método Espectrofotométrico: 90 LOVIBOND	10 mg/L Cl^-	SR***
Sulfatos Método Espectrofotométrico: 360 LOVIBOND	< 2 mg/L SO_4^{-2}	250 mg/L SO_4^{-2}

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 µg/mL
1ppb = 1 µg/kg = 1 µg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

Informe de Resultados No. 1-1611/23

Amonio no ionizable Método Espectrofotométrico: 62 LOVIBOND	0,02 mg/L NH_3	0,02 mg/L NH_3
Nitrato Método Espectrofotométrico: 8039 HACH	0,6 mg/L N	10 mg/L N
Nitrito Método Espectrofotométrico: 8507 HACH	0,003 mg/L N	1 mg/L N
Color Método Espectrofotométrico: 203 ORBECO HELLIGE	**112 mg/L Pt-Co**	75 mg/L Pt-Co
DBO (5 días, 20°C) Método: SM 5210 B	1,9 mg/L O_2	5 mg/L
Oxígeno disuelto Método: Medidor de oxígeno disuelto ORION STAR A223/RDO	8,58 mg/L O_2	No inferior a 5 mg/L O_2
Nitrógeno total Método Espectrofotométrico: 10071 HACH	**2,3 mg/L N**	0,6 mg/L N
Sólidos totales disueltos Método: APHA 2540 C	133 mg/L	500 mg/L
Cianatos Método: APHA 4500 – CN L	< 0,2 mg/L	0,2 mg/L
Cromo hexavalente Método Espectrofotométrico: 10218/10219 HACH	0,14 mg/L	0,5 mg/L

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 μg/mL
1ppb = 1 μg/kg = 1 μg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

Informe de Resultados No. 1-1611/23

Cromo trivalente Método Espectrofotométrico: 10219 HACH	< 0,03 mg/L	2 mg/L
Bifenilos Policlorados (PCB)**** Método: GC/MS	< 0,0002 mg/L	SR***
Dureza cálcica Método: Titulométrico	31 mg/L $CaCO_3$	300 mg/L $CaCO_3$
Materia Flotante Método: NMX-AA-006-SCFI-2000	Ausencia	Ausencia
Aceites y grasas Método: SM 5520 B	8 mg/L	Ausencia
<u>Pesticidas</u>		
Endosulfan I y II Método: GC/MS Límite de cuantificación: 0,010 mg/L	< 0,010 mg/L	0,056 mg/L
Diazinon Método: GC/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,005 mg/L
4,4 DDT Método: GC/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	0,002 mg/L
Endrin Método: GC/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,002 mg/L

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 μg/mL
1ppb = 1 μg/kg = 1 μg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

Informe de Resultados No. 1-1611/23

Elementos químicos		
Aluminio (Al) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	**1,46 mg/L**	0,2 mg/L
Hierro soluble (Fe) Método: ICP/MS Límite de cuantificación: 0,1 mg/L	**1,0 mg/L**	0,3 mg/L
Sodio (Na) Método: ICP/MS Límite de cuantificación: 1 mg/L	18 mg/L	200 mg/L
Selenio (Se) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,01 mg/L
Manganeso (Mn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	0,1 mg/L
Bario (Ba) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	0,06 mg/L	2 mg/L
Arsénico (As) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	0,002 mg/L	0,01 mg/L
Plomo (Pb) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,01 mg/L
Cadmio (Cd) Método: ICP/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	0,001 mg/L

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 µg/mL
1ppb = 1 µg/kg = 1 µg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

Informe de Resultados No. 1-1611/23

Cobre (Cu) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	1 mg/L
Estaño (Sn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	2 mg/L
Mercurio total (Hg) Método: ICP/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	SR***
Níquel (Ni) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	0,002 mg/L	0,025 mg/L
Zinc (Zn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	3 mg/L
Fósforo total (P) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	**0,12 mg/L**	0,050 mg/L

Observaciones: Los resultados obtenidos sólo afectan a la muestra recolectada y analizada en EcoNatura, un laboratorio del Grupo Multilab S.A.

**Referencia tomada de la Resolución Nº 222/02 emitida por la Secretaria del Medio Ambiente, por la cual se establece el padrón de calidad de las aguas en el territorio nacional. Clase 2. Art. 3º.

***SR: Sin Referencia.

****Bifenilos Policlorados monitoreados: PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 y PCB 180.

Comentarios: No se registran.

Analizado por:	Autorizado por:
Viviana Báez Bioquímica Responsable del Laboratorio de Medio Ambiente	**Alicia Salgueiro** Bioquímica - Reg. Prof. No. 1898 Director Técnico

Fecha y Hora del Informe: 13/07/2023; 14:21 h
Fin del informe.

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 µg/mL
1ppb = 1 µg/kg = 1 µg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

Informe de Resultados No. 1-1612/23

Determinación solicitada	Matriz
Análisis fisicoquímicos **Elementos químicos**	Agua de río

*Datos del cliente**	*Datos de la muestra*
Solicitante: Sra. Renata Moretti – JGP CONSULTORÍA E PARTICIPAÇÕES LTDA **Dirección:** Villeta **Muestra identificada como:** AGUA DE RIO PY 2 – MEDIO PUNTO AGUAS ARRIBA DEL VERTIDO DE EFLUENTES	**Código interno de EcoNatura**: 1-29043 **Fecha de recolección:** 14/06/2023 **Descripción de la muestra:** La muestra fue recolectada por personal de Grupo Multilab S.A. en 2 (dos) botellas de vidrio ámbar y 1 (una) botella de plástico conteniendo aproximadamente 1 (un) litro cada una.

Fecha de inicio del análisis: 14/06/2023
Fecha de finalización del análisis: 12/07/2023

*El Laboratorio es responsable de la información suministrada en el informe, excepto cuando la misma es proporcionada por el cliente.

Resultados

Análisis	Resultados	Valores de referencia**
pH Método: Potenciométrico	7,64	6,00 a 9,00
Turbidez Método: Nefelométrico ORBECO HELLIGE	10 NTU	100 NTU
Cloruros Método Espectrofotométrico: 90 LOVIBOND	8 mg/L Cl^-	SR***
Sulfatos Método Espectrofotométrico: 360 LOVIBOND	< 2 mg/L SO_4^{-2}	250 mg/L SO_4^{-2}

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 µg/mL
1ppb = 1 µg/kg = 1 µg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

Informe de Resultados No. 1-1612/23

Amonio no ionizable Método Espectrofotométrico: 62 LOVIBOND	0,02 mg/L NH_3	0,02 mg/L NH_3
Nitrato Método Espectrofotométrico: 8039 HACH	0,4 mg/L N	10 mg/L N
Nitrito Método Espectrofotométrico: 8507 HACH	0,002 mg/L N	1 mg/L N
Color Método Espectrofotométrico: 203 ORBECO HELLIGE	**110 mg/L Pt-Co**	75 mg/L Pt-Co
DBO (5 días, 20°C) Método: SM 5210 B	2,0 mg/L O_2	5 mg/L
Oxígeno disuelto Método: Medidor de oxígeno disuelto ORION STAR A223/RDO	8,30 mg/L O_2	No inferior a 5 mg/L O_2
Nitrógeno total Método Espectrofotométrico: 10071 HACH	**0,9 mg/L N**	0,6 mg/L N
Sólidos totales disueltos Método: APHA 2540 C	130 mg/L	500 mg/L
Cianatos Método: APHA 4500 – CN L	< 0,2 mg/L	0,2 mg/L
Cromo hexavalente Método Espectrofotométrico: 10218/10219 HACH	0,24 mg/L	0,5 mg/L

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 µg/mL
1ppb = 1 µg/kg = 1 µg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

Informe de Resultados No. 1-1612/23

Cromo trivalente Método Espectrofotométrico: 10219 HACH	< 0,03 mg/L	2 mg/L
Bifenilos Policlorados (PCB)** Método: GC/MS	< 0,0002 mg/L	SR***
Dureza cálcica Método: Titulométrico	33 mg/L $CaCO_3$	300 mg/L $CaCO_3$
Materia Flotante Método: NMX-AA-006-SCFI-2000	Ausencia	Ausencia
Aceites y grasas Método: SM 5520 B	9 mg/L	Ausencia
<u>Pesticidas</u>		
Endosulfan I y II Método: GC/MS Límite de cuantificación: 0,010 mg/L	< 0,010 mg/L	0,056 mg/L
Diazinon Método: GC/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,005 mg/L
4,4 DDT Método: GC/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	0,002 mg/L
Endrin Método: GC/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,002 mg/L

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 µg/mL
1ppb = 1 µg/kg = 1 µg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

Informe de Resultados No. 1-1612/23

Elementos químicos		
Aluminio (Al) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	**1,43 mg/L**	0,2 mg/L
Hierro soluble (Fe) Método: ICP/MS Límite de cuantificación: 0,1 mg/L	**1,0 mg/L**	0,3 mg/L
Sodio (Na) Método: ICP/MS Límite de cuantificación: 1 mg/L	14 mg/L	200 mg/L
Selenio (Se) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,01 mg/L
Manganeso (Mn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	0,1 mg/L
Bario (Ba) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	0,06 mg/L	2 mg/L
Arsénico (As) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	0,003 mg/L	0,01 mg/L
Plomo (Pb) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,01 mg/L
Cadmio (Cd) Método: ICP/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	0,001 mg/L

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 µg/mL
1ppb = 1 µg/kg = 1 µg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

Informe de Resultados No. 1-1612/23

Cobre (Cu) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	1 mg/L
Estaño (Sn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	2 mg/L
Mercurio total (Hg) Método: ICP/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	SR***
Níquel (Ni) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	0,001 mg/L	0,025 mg/L
Zinc (Zn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	3 mg/L
Fósforo total (P) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	**0,10 mg/L**	0,050 mg/L

Observaciones: Los resultados obtenidos sólo afectan a la muestra recolectada y analizada en EcoNatura, un laboratorio del Grupo Multilab S.A.

**Referencia tomada de la Resolución Nº 222/02 emitida por la Secretaria del Medio Ambiente, por la cual se establece el padrón de calidad de las aguas en el territorio nacional. Clase 2. Art. 3º.

***SR: Sin Referencia.

****Bifenilos Policlorados monitoreados: PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 y PCB 180.

Comentarios: No se registran.

Analizado por:	**Autorizado por:**
Viviana Báez Bioquímica Responsable del Laboratorio de Medio Ambiente	**Alicia Salgueiro** Bioquímica - Reg. Prof. No. 1898 Director Técnico

EcoNatura Laboratorio de Control de Alimentos y Medio Ambiente

Fecha y Hora del Informe: 13/07/2023; 14:25 h
Fin del informe.

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 µg/mL
1ppb = 1 µg/kg = 1 µg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

GRUPO MULTILAB

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EcoNatura
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de Alimentos y Medio Ambiente

Informe de Resultados No. 1-1613/23

Determinación solicitada	Matriz
Análisis fisicoquímicos Elementos químicos	Agua de río

*Datos del cliente**	*Datos de la muestra*
Solicitante: Sra. Renata Moretti – JGP CONSULTORÍA E PARTICIPAÇÕES LTDA **Dirección:** Villeta **Muestra identificada como:** AGUA DE RIO PY 3 PUNTO AGUAS ABAJO DEL VERTIDO DE EFLUENTES	**Código interno de EcoNatura**: 1-29044 **Fecha de recolección:** 14/06/2023 **Descripción de la muestra:** La muestra fue recolectada por personal de Grupo Multilab S.A. en 2 (dos) botellas de vidrio ámbar y 1 (una) botella de plástico conteniendo aproximadamente 1 (un) litro cada una.

Fecha de inicio del análisis: 14/06/2023

Fecha de finalización del análisis: 12/07/2023

*El Laboratorio es responsable de la información suministrada en el informe, excepto cuando la misma es proporcionada por el cliente.

Resultados

Análisis	Resultados	Valores de referencia**
pH Método: Potenciométrico	7,68	6,00 a 9,00
Turbidez Método: Nefelométrico ORBECO HELLIGE	10 NTU	100 NTU
Cloruros Método Espectrofotométrico: 90 LOVIBOND	12 mg/L Cl^-	SR***
Sulfatos Método Espectrofotométrico: 360 LOVIBOND	< 2 mg/L SO_4^{-2}	250 mg/L SO_4^{-2}

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 µg/mL
1ppb = 1 µg/kg = 1 µg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

Informe de Resultados No. 1-1613/23

Amonio no ionizable Método Espectrofotométrico: 62 LOVIBOND	0,02 mg/L NH_3	0,02 mg/L NH_3
Nitrato Método Espectrofotométrico: 8039 HACH	0,2 mg/L N	10 mg/L N
Nitrito Método Espectrofotométrico: 8507 HACH	0,003 mg/L N	1 mg/L N
Color Método Espectrofotométrico: 203 ORBECO HELLIGE	**111 mg/L Pt-Co**	75 mg/L Pt-Co
DBO (5 días, 20°C) Método: SM 5210 B	1,9 mg/L O_2	5 mg/L
Oxígeno disuelto Método: Medidor de oxígeno disuelto ORION STAR A223/RDO	8,51 mg/L O_2	No inferior a 5 mg/L O_2
Nitrógeno total Método Espectrofotométrico: 10071 HACH	**1,5 mg/L N**	0,6 mg/L N
Sólidos totales disueltos Método: APHA 2540 C	137 mg/L	500 mg/L
Cianatos Método: APHA 4500 – CN L	< 0,2 mg/L	0,2 mg/L
Cromo hexavalente Método Espectrofotométrico: 10218/10219 HACH	0,36 mg/L	0,5 mg/L

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 µg/mL
1ppb = 1 µg/kg = 1 µg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

Informe de Resultados No. 1-1613/23

Cromo trivalente Método Espectrofotométrico: 10219 HACH	< 0,03 mg/L	2 mg/L
Bifenilos Policlorados (PCB)**** Método: GC/MS	< 0,0002 mg/L	SR***
Dureza cálcica Método: Titulométrico	36 mg/L $CaCO_3$	300 mg/L $CaCO_3$
Materia Flotante Método: NMX-AA-006-SCFI-2000	Ausencia	Ausencia
Aceites y grasas Método: SM 5520 B	7 mg/L	Ausencia
<u>Pesticidas</u>		
Endosulfan I y II Método: GC/MS Límite de cuantificación: 0,010 mg/L	< 0,010 mg/L	0,056 mg/L
Diazinon Método: GC/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,005 mg/L
4,4 DDT Método: GC/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	0,002 mg/L
Endrin Método: GC/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,002 mg/L

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 μg/mL
1ppb = 1 μg/kg = 1 μg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

Informe de Resultados No. 1-1613/23

Elementos químicos		
Aluminio (Al) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	**1,37 mg/L**	0,2 mg/L
Hierro soluble (Fe) Método: ICP/MS Límite de cuantificación: 0,1 mg/L	**1,0 mg/L**	0,3 mg/L
Sodio (Na) Método: ICP/MS Límite de cuantificación: 1 mg/L	13 mg/L	200 mg/L
Selenio (Se) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,01 mg/L
Manganeso (Mn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	0,1 mg/L
Bario (Ba) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	0,06 mg/L	2 mg/L
Arsénico (As) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	0,002 mg/L	0,01 mg/L
Plomo (Pb) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	0,001 mg/L	0,01 mg/L
Cadmio (Cd) Método: ICP/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	0,001 mg/L

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 µg/mL
1ppb = 1 µg/kg = 1 µg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

Informe de Resultados No. 1-1613/23

Cobre (Cu) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	1 mg/L
Estaño (Sn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	2 mg/L
Mercurio total (Hg) Método: ICP/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	SR***
Níquel (Ni) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	0,001 mg/L	0,025 mg/L
Zinc (Zn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	3 mg/L
Fósforo total (P) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	**0,10 mg/L**	0,050 mg/L

Observaciones: Los resultados obtenidos sólo afectan a la muestra recolectada y analizada en EcoNatura, un laboratorio del Grupo Multilab S.A.

**Referencia tomada de la Resolución Nº 222/02 emitida por la Secretaria del Medio Ambiente, por la cual se establece el padrón de calidad de las aguas en el territorio nacional. Clase 2. Art. 3º.

***SR: Sin Referencia.

****Bifenilos Policlorados monitoreados: PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 y PCB 180.

Comentarios: No se registran.

Analizado por:	Autorizado por:
Viviana Báez Bioquímica Responsable del Laboratorio de Medio Ambiente	Alicia Salgueiro Bioquímica - Reg. Prof. No. 1898 Director Técnico

Fecha y Hora del Informe: 13/07/2023; 14:28 h
Fin del informe.

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 µg/mL
1ppb = 1 µg/kg = 1 µg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

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Informe de Resultados Nº 1709/23

Determinación Solicitada: Análisis Microbiológico según Art. Nº 7 de la Resolución 222/02 de la SEAM.	**Matriz:** Agua de Rio.
Solicitado por: JGP CONSULTORIA E PARTICIPAÇÕES LTDA.	**Dirección:** Villeta – Paraguay.

Datos de la muestra

Identificación de la muestra: Agua de Rio - 1709/23.

Nombre del Producto: Agua de Rio Py 1 arriba.

Contenido: Agua de Rio.

Presentación: Frasco estéril.

No. de Lote: N/A.

Vencimiento/Fecha de elaboración: N/A.

Cantidad de muestra: 2 frascos x 80mL.

Fecha y Hora de Recolección de la muestra: 14/06/2023; 11:00 h.

Fecha y Hora de Recepción de la muestra: 14/06/2023; 17:52 h.

Muestra recolectada por: Téc. Carlos Ruiz.

Descripción del punto de muestreo: La muestra se tomó con el muestreador de mango largo a 30 mts. aprox. de la orilla. Temperatura de muestreo: 17ºC.

Descripción de la muestra: Apariencia turbia. Temperatura de recepción: 13,2ºC.

Código interno: 3-12.042.

Metodología Analítica:

_*Coliformes Fecales o Termotolerantes, Coliformes Totales:* Técnica NMP/100mL (Número más probable): Caldo Lactosado. Temperatura de Incubación: 35°C - 37 °C. Tiempo de Incubación: 24 - 48 h. Caldo *E. coli*. Temperatura de Incubación: 44°C. Tiempo de incubación: 24 h.

Fecha de inicio del Análisis: 15/06/2023

Fecha de finalización del Análisis: 19/06/2023

Ensayos	Especificaciones*	Resultados
Coliformes Totales	Informativo	9180 NMP/100mL
Coliformes Fecales	4000 NMP/100mL	348 NMP/100mL

*Referencia tomada de la Resolución Nº 222/02 – Artículo 7 de la Secretaría del Ambiente.

Observaciones Generales: Los resultados obtenidos solo afectan a la muestra recepcionada y analizada en BioControl, un Laboratorio del Grupo Multilab S.A.

Comentarios: No se registran.

Analizado por:	Revisado y Autorizado por:
Lic. Biotec. Andrea Magali Planás Lugo Reg. Prof. Nº 055 **Analista**	p.a. Q.F. Grecia Doldán Reg. Prof. Nº. 1.657 **Director Técnico**

BioControl Microbiología Industrial

Fecha de Informe: 19/06/2023

Fin de Informe.

El laboratorio no es responsable de la información proporcionada por el cliente, que puede afectar la validez de los resultados.

GRUPO MULTILAB

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BioControl
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Informe de Resultados Nº 1710/23

Determinación Solicitada: Análisis Microbiológico según Art. Nº 7 de la Resolución 222/02 de la SEAM.	**Matriz:** Agua de Rio.
Solicitado por: JGP CONSULTORIA E PARTICIPAÇÕES LTDA.	**Dirección:** Villeta – Paraguay.

Datos de la muestra

Identificación de la muestra: Agua de Rio - 1710/23.

Nombre del Producto: Agua de Rio Py 2 medio, punto aguas arriba del vertido de efluentes.

Contenido: Agua de Rio.

Presentación: Frasco estéril.

No. de Lote: N/A.

Vencimiento/Fecha de elaboración: N/A.

Cantidad de muestra: 2 frascos x 80mL.

Fecha y Hora de Recolección de la muestra: 14/06/2023; 11:30 h.

Fecha y Hora de Recepción de la muestra: 14/06/2023; 17:52 h.

Muestra recolectada por: Téc. Carlos Ruiz.

Descripción del punto de muestreo: La muestra se tomó con el muestreador de mango largo a 20 mts. aprox. de la orilla. Temperatura de muestreo: 19,9ºC.

Descripción de la muestra: Apariencia turbia. Temperatura de recepción: 13,5ºC.

Código interno: 3-12.043.

Metodología Analítica:

_*Coliformes Fecales o Termotolerantes, Coliformes Totales:* Técnica NMP/100mL (Número más probable): Caldo Lactosado. Temperatura de Incubación: 35°C - 37 °C. Tiempo de Incubación: 24 - 48 h. Caldo *E. coli*. Temperatura de Incubación: 44°C. Tiempo de incubación: 24 h.

Fecha de inicio del Análisis: 15/06/2023

Fecha de finalización del Análisis: 19/06/2023

Ensayos	Especificaciones*	Resultados
Coliformes Totales	Informativo	5420 NMP/100mL
Coliformes Fecales	4000 NMP/100mL	330 NMP/100mL

*Referencia tomada de la Resolución Nº 222/02 – Artículo 7 de la Secretaría del Ambiente.

Observaciones Generales: Los resultados obtenidos solo afectan a la muestra recepcionada y analizada en BioControl, un Laboratorio del Grupo Multilab S.A.

Comentarios: No se registran.

Analizado por:	Revisado y Autorizado por:
BioControl Microbiología Industrial	PA
Lic. Biotec. Andrea Magali Planás Lugo Reg. Prof. Nº 055 **Analista**	Q.F. Grecia Doldán Reg. Prof. Nº. 1.657 **Director Técnico**

Fecha de Informe: 19/06/2023

Fin de Informe.

El laboratorio no es responsable de la información proporcionada por el cliente, que puede afectar la validez de los resultados.

Informe de Resultados Nº 1711/23

Determinación Solicitada: Análisis Microbiológico según Art. Nº 7 de la Resolución 222/02 de la SEAM.	**Matriz:** Agua de Rio.
Solicitado por: JGP CONSULTORIA E PARTICIPAÇÕES LTDA.	**Dirección:** Villeta – Paraguay.

Datos de la muestra

Identificación de la muestra: Agua de Rio - 1711/23.

Nombre del Producto: Agua de Rio Py 3, punto aguas abajo del vertido de efluentes.

Contenido: Agua de Rio.

Presentación: Frasco estéril.

No. de Lote: N/A.

Vencimiento/Fecha de elaboración: N/A.

Cantidad de muestra: 2 frascos x 80mL.

Fecha y Hora de Recolección de la muestra: 14/06/2023; 11:50 h.

Fecha y Hora de Recepción de la muestra: 14/06/2023; 17:52 h.

Muestra recolectada por: Téc. Carlos Ruiz.

Descripción del punto de muestreo: La muestra se tomó con el muestreador de mango largo a 20 mts. aprox. de la orilla. Temperatura de muestreo: 17,8ºC.

Descripción de la muestra: Apariencia turbia. Temperatura de recepción: 13,1ºC.

Código interno: 3-12.044.

Metodología Analítica:

_*Coliformes Fecales o Termotolerantes, Coliformes Totales:* Técnica NMP/100mL (Número más probable): Caldo Lactosado. Temperatura de Incubación: 35°C - 37 °C. Tiempo de Incubación: 24 - 48 h. Caldo *E. coli*. Temperatura de Incubación: 44°C. Tiempo de incubación: 24 h.

Fecha de inicio del Análisis: 15/06/2023

Fecha de finalización del Análisis: 19/06/2023

Ensayos	Especificaciones*	Resultados
Coliformes Totales	Informativo	5420 NMP/100mL
Coliformes Fecales	4000 NMP/100mL	348 NMP/100mL

*Referencia tomada de la Resolución Nº 222/02 – Artículo 7 de la Secretaría del Ambiente.

Observaciones Generales: Los resultados obtenidos solo afectan a la muestra recepcionada y analizada en BioControl, un Laboratorio del Grupo Multilab S.A.

Comentarios: No se registran.

Analizado por:	Revisado y Autorizado por:
BioControl Microbiología Industrial	PA
Lic. Biotec. Andrea Magali Planás Lugo	**Q.F. Grecia Doldán**
Reg. Prof. Nº 055	Reg. Prof. Nº. 1.657
Analista	**Director Técnico**

Fecha de Informe: 19/06/2023

Fin de Informe.

El laboratorio no es responsable de la información proporcionada por el cliente, que puede afectar la validez de los resultados.

Informe de Resultados No. 1-2828/23

Determinación solicitada	Matriz
Análisis fisicoquímicos **Elementos químicos**	Agua de piezómetro

*Datos del cliente**	*Datos de la muestra*
Solicitante: Sra. Renata Moretti – JGP CONSULTORÍA E PARTICIPAÇÕES LTDA **Dirección:** Villeta **Muestra identificada como:** AGUA DE PIEZÓMETRO	**Código interno de EcoNatura**: 1-30259 **Fecha de recolección:** 27/06/2023 **Descripción de la muestra:** La muestra fue recolectada por personal de Grupo Multilab S.A. en 2 (dos) botellas de vidrio ámbar y 1 (una) botella de plástico conteniendo aproximadamente 1 (un) litro cada una.

Fecha de inicio del análisis: 27/06/2023

Fecha de finalización del análisis: 26/07/2023

*El Laboratorio es responsable de la información suministrada en el informe, excepto cuando la misma es proporcionada por el cliente.

Resultados

Análisis	Resultados	Valores de referencia**
pH Método: Potenciométrico	7,17	6,00 a 9,00
Turbidez Método: Nefelométrico ORBECO HELLIGE	14 NTU	100 NTU
Cloruros Método Espectrofotométrico: 8113 HACH	20 mg/L Cl^-	SR***
Sulfatos Método Espectrofotométrico: 360 LOVIBOND	3 mg/L SO_4^{-2}	250 mg/L SO_4^{-2}

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 µg/mL
1ppb = 1 µg/kg = 1 µg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

Informe de Resultados No. 1-2828/23

Amonio no ionizable Método Espectrofotométrico: 62 LOVIBOND	0,02 mg/L NH_3	0,02 mg/L NH_3
Nitrato Método Espectrofotométrico: 8039 HACH	1 mg/L N	10 mg/L N
Nitrito Método Espectrofotométrico: 8507 HACH	< 0,002 mg/L N	1 mg/L N
Color Método Espectrofotométrico: 203 ORBECO HELLIGE	46 mg/L Pt-Co	75 mg/L Pt-Co
DBO (5 días, 20°C) Método: SM 5210 B	**202 mg/L O_2**	5 mg/L
Oxígeno disuelto Método: Medidor de oxígeno disuelto ORION STAR A223/RDO	**0,22 mg/L O_2**	No inferior a 5 mg/L O_2
Nitrógeno total Método Espectrofotométrico: 10071 HACH	**2,9 mg/L N**	0,6 mg/L N
Sólidos totales disueltos Método: APHA 2540 C	**597 mg/L**	500 mg/L
Cianatos Método: APHA 4500 – CN L	< 0,2 mg/L	0,2 mg/L
Cromo hexavalente Método Espectrofotométrico: 10218/10219 HACH	0,27 mg/L	0,5 mg/L

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 µg/mL
1ppb = 1 µg/kg = 1 µg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

Informe de Resultados No. 1-2828/23

Cromo trivalente Método Espectrofotométrico: 10219 HACH	< 0,03 mg/L	2 mg/L
Bifenilos Policlorados (PCB)**** Método: GC/MS	< 0,0002 mg/L	SR***
Dureza cálcica Método: Titulométrico	102 mg/L $CaCO_3$	300 mg/L $CaCO_3$
Materia Flotante Método: NMX-AA-006-SCFI-2000	Ausencia	Ausencia
Aceites y grasas Método: SM 5520 B	4 mg/L	Ausencia
<u>Pesticidas</u>		
Endosulfan I y II Método: GC/MS Límite de cuantificación: 0,010 mg/L	< 0,010 mg/L	0,056 mg/L
Diazinon Método: GC/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,005 mg/L
4,4 DDT Método: GC/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	0,002 mg/L
Endrin Método: GC/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,002 mg/L

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 µg/mL
1ppb = 1 µg/kg = 1 µg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

Informe de Resultados No. 1-2828/23

Elementos químicos		
Aluminio (Al) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	0,20 mg/L	0,2 mg/L
Hierro soluble (Fe) Método: ICP/MS Límite de cuantificación: 0,1 mg/L	**0,7 mg/L**	0,3 mg/L
Sodio (Na) Método: ICP/MS Límite de cuantificación: 1 mg/L	94 mg/L	200 mg/L
Selenio (Se) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	< 0,001 mg/L	0,01 mg/L
Manganeso (Mn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	**1,16 mg/L**	0,1 mg/L
Bario (Ba) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	0,08 mg/L	2 mg/L
Arsénico (As) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	**0,058 mg/L**	0,01 mg/L
Plomo (Pb) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	0,002 mg/L	0,01 mg/L
Cadmio (Cd) Método: ICP/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	0,001 mg/L

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 µg/mL
1ppb = 1 µg/kg = 1 µg/L = 1 ng/mL
LMR = Límite Máximo de Residuo
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Informe de Resultados No. 1-2828/23

Cobre (Cu) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	1 mg/L
Estaño (Sn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	2 mg/L
Mercurio total (Hg) Método: ICP/MS Límite de cuantificación: 0,0005 mg/L	< 0,0005 mg/L	SR***
Níquel (Ni) Método: ICP/MS Límite de cuantificación: 0,001 mg/L	0,001 mg/L	0,025 mg/L
Zinc (Zn) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	< 0,05 mg/L	3 mg/L
Fósforo total (P) Método: ICP/MS Límite de cuantificación: 0,05 mg/L	**0,24 mg/L**	0,050 mg/L

Observaciones: Los resultados obtenidos sólo afectan a la muestra recolectada y analizada en EcoNatura, un laboratorio del Grupo Multilab S.A.

**Referencia tomada de la Resolución Nº 222/02 emitida por la Secretaria del Medio Ambiente, por la cual se establece el padrón de calidad de las aguas en el territorio nacional. Clase 2. Art. 3º.

***SR: Sin Referencia.

****Bifenilos Policlorados monitoreados: PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153 y PCB 180.

Comentarios: No se registran.

Analizado por:	Autorizado por:
Viviana Báez Bioquímica Responsable del Laboratorio de Medio Ambiente	Alicia Salgueiro Bioquímica - Reg. Prof. No. 1898 Director Técnico

Fecha y Hora del Informe: 27/07/2023; 16:27 h
Fin del informe.

Equivalencias:
1 ppb = 0,000000001 kg/kg (peso/peso)
1 ppm = 0,000001 kg/kg (peso/peso)
1ppm = 1 mg/kg = 1 mg/L = 1 µg/mL
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LMR = Límite Máximo de Residuo
LOQ = Límite de Cuantificación

UNIVERSIDAD NACIONAL DE ASUNCIÓN
Facultad de Ciencias Exactas y Naturales
Laboratorio de Calidad de Agua

INFORME DE ENSAYO

INF.1534/2023

Solicitante: JGP Y PARTICIPACIONES LTDA.	Solicitud de trabajo Nº: 850/2023
Dirección: San Pablo – Brazil	Código de Ítem: 1502

Descripción de ítem: Datos conforme a la cadena custodio N° 130/2023: Sedimento de fondo proveniente del agua de Río Paraguay. Ubicación: -25.710233S, -57.726728W. Distrito: Villeta. Departamento: Central. Fecha de muestreo: 19/09/2023. Hora de muestreo: 08:57. Responsable del muestreo: Personal de Laboratorio.

Fecha de recepción: 19/09/2023	Fecha de ejecución del ensayo: 19/09/2023	Fecha del informe: 12/10/2023

Determinaciones	Métodos	Resultados	Unidad	Referencia No Aplica
Temperatura	SM 2550 B	25,0	ºC	--
Humedad	Gravimétrico - NN	40,6	% p/p	--
Fósforo total	SM 4500-P B, SM 4500-P E	103,0	mg/kg	--
Sólidos totales	SM 2540 B	351,85	mg/kg	--
N. T. K. (como N)	SM 4500-N B	7,30	mg/kg	--
N-Organico Disuelto (como N)	SM 4500-N B	5,00	mg/kg	--
Aluminio (Al)	SM 3500-Al D	6,65	mg/kg	--
Boro (B)	SM 4500-B B	<5,0	mg/kg	--
Hierro Total (Fe^{+3})	SM 3500-Fe D	2597,50	mg/kg	--
Cadmio (Cd)	SM 3500-Cd B	0,30	mg/kg	--
Cromo (Cr) Total	SM 3500-Cr D	6,90	mg/kg	--
Cromo (+6) hexavalente	SM 3500-Cr D	1,33	mg/kg	--
Níquel (Ni)	SM 3030, SM 3500-Ni B	22,50	mg/kg	--
Plomo (Pb)	SM 3500-Pb B	<0,1	mg/kg	--
Plata (Ag)	SM 303, SM 3500-Ag B	9,60	mg/kg	--
Mercurio (Hg) total	SM 3500-Hg B	<0,1	mg/kg	--
Zinc (Zn)	SM 3030, SM 3500-Zn B	50,30	mg/kg	--

Abreviaturas: ºC = grados Celsius, % p/p = porcentaje peso/peso, mg/kg = miligramos por kilogramo, N.T.K. = Nitrógeno total kjeldahl, < = menor que, SM = Método Estándar - Métodos Normalizados para el análisis de aguas potables y residuales, edición Nº 17 (APHA-AWWA-WPCF). NN = no normalizado.

Ítem: muestra ensayada

Notas:

- Este informe no podrá ser reproducido parcialmente sin la aprobación por escrito del Laboratorio.
- El(Los) resultado(s) obtenido(s) corresponde(n) únicamente a la(s) muestra(s) ensayada(s) que se refieren a la cadena de custodia mencionada.
- Nombre del contacto: Ing. Silvio Jara Telefono: 0981 455 493
- Ubicación del punto de muestreo:

Laboratorio de Calidad de Agua
FACEN
Facultad de Ciencias Exactas y Naturales
Universidad Nacional de Asunción

Prof. MSc. Estanislaa Acosta Morales
Jefe, Laboratorio de Calidad de Agua

Fin del informe
Pag. 1/1

REG 063.07

Annex 3 – Flooding and Surface Runoff Study

STUDY OF FLOODABILITY AND SURFACE RUNOFF PATTERN

Determination of maximum water levels and safety level for the platform of a hydrogen and green ammonia production industry in Villeta.

Brief

The purpose of this study is to develop design recommendations for the ATOME industrial plant through the modeling of the rainwater runoff pattern in a property destined for the installation of an industry. Likewise, comments are presented regarding the impact of Climate Change on the availability of water resources and the levels of the Paraguay River

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1. Introduction

ATOME Paraguay S.A. is a subsidiary of the first company dedicated to the production of hydrogen (H2), ammonia (NH3) and green fertilizers listed on the London Stock Exchange, ATOME Energy PLC. Currently, ATOME Paraguay is developing a project in the district of Villeta dedicated to the production of green fertilizers with an electrical power demand of 120 MW. The Villeta project will be phase 1 of a project that includes a total of 420 MW of power. Phase 2 of the project will be carried out in the future in another area of the country and will also focus on the production of hydrogen, ammonia and green fertilizers. Phase 1 of the ATOME project involves the construction of the largest green ammonia and calcium ammonium nitrate (CAN) plant in Latin America (120 MW), which is expected to start operating in early 2026. This plant will be the first with the capacity to produce green fertilizers on an industrial scale and at a constant rate (250,000 tons/year of CAN), from hydroelectricity; 100% renewable energy.

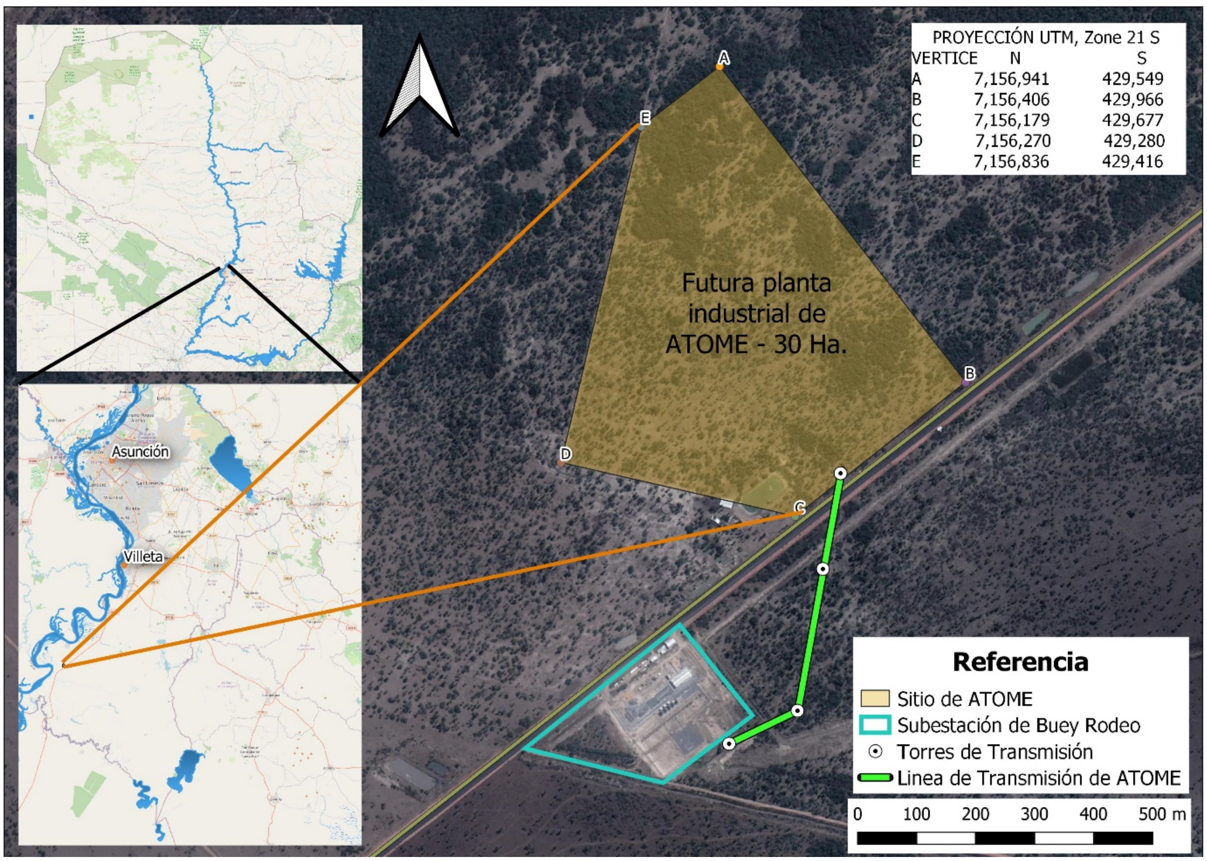

Figure 1 Location of the ATOME industrial plant in the district of Villeta. The industrial plant will be focused on the production of green fertilizers based on green hydrogen and with a power consumption of 120 MW

In this way, the Project will have the capacity to produce the world's first truly green fertilizer and the potential to avoid 525,000 t-CO2-eq/year of carbon emissions in the fertilizer sector. When considering the useful life of the Project (25 years), this impact would translate into 13,125,000 t CO2-eq avoided, allowing the country to position itself as an agent of change in compliance with the United Nations

Framework Convention and SDG 13 regarding the adoption of action measures against climate change and its effects.

This document is a summary of the hydrological and hydraulic studies carried out to evaluate the maximum water levels and runoff pattern on the property where the hydrogen and green fertilizer production industry will be installed.

2. Topography

In order to make the level of the Paraguay River compatible with the topography used in the ATOME industrial project, a link was made between the Villeta hydrometric rule and the First Order Point of the Geodetic Network of Paraguay 100056 Guyrati (UTM coordinates - WGS84 N: 7.170476.537; This 443,061.765) was the basis of the topographic study of the project carried out by the consulting firm IKE.

Based on the topographic analysis, the delta H necessary to adapt the level levels of the Paraguay River in Villeta to the project datum is determined.

Table 1 Difference Between Project Datum and Villeta Hydrometric Rule Datum

Zero of the Villeta Hydrometric Rule (NMM)[1]	52.86
Zero of the Villeta Hydrometric Rule (Pyto's Datum associated with the first-order cairn 100056 Guyrati)	68.33
Delta H	15.47

As the ATOME industrial site is located 49 km downstream of the Villeta hydrometer, an adjustment must be made to the level, as it will be lower (in elevation) in the vicinity of ATOME (see the following figures).

[1] Mean Sea Level (Associated with the Mar del Plata tide gauge)

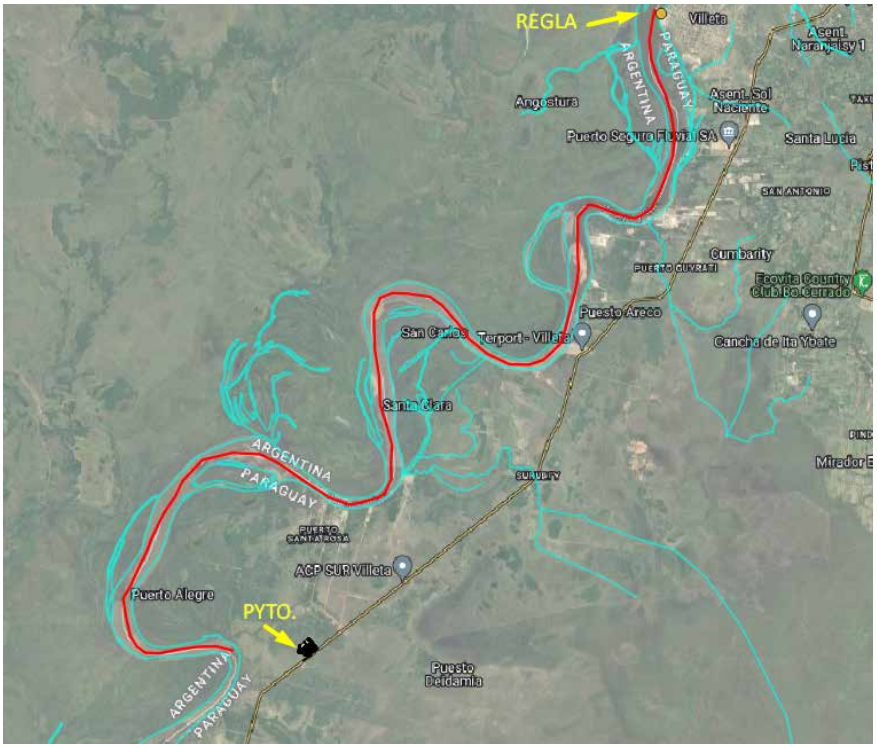

Figure 2 Distance of 49 km (red line) between the location of the Villeta rule (orange dot) and the project area

This difference in the level of the water between Villeta and the vicinity of ATOME is obtained from a hydrodynamic model of the Paraguay River (Universidad Católica Nuestra Señora de la Asunción (UCA), 2018) that includes bathymetric information from the city of Porto Murtinho to Pilar, including the analyzed stretch.

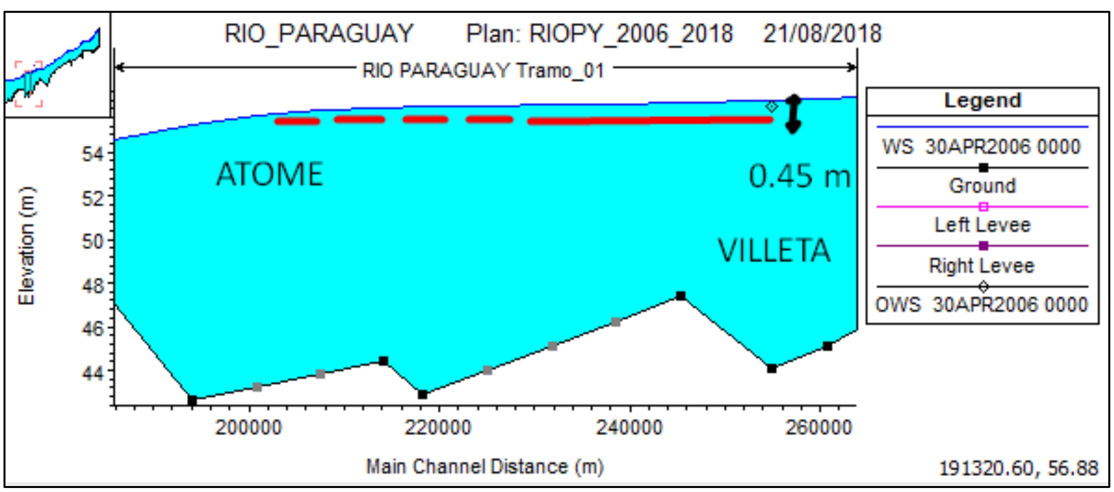

Figure 3 Longitudinal profile of the Paraguay River between Villeta and the ATOME riparian area

As shown in the figure above, this difference in water level is around 45 cm.

3. Area of Study

The study area has a rather complex general runoff due to important anthropic intervention in the area. Large canals are observed that strategically conduct water for industrial or cultivation purposes, considerably reducing the area of contribution to the study site. This is seen in sufficient detail in the figure below.

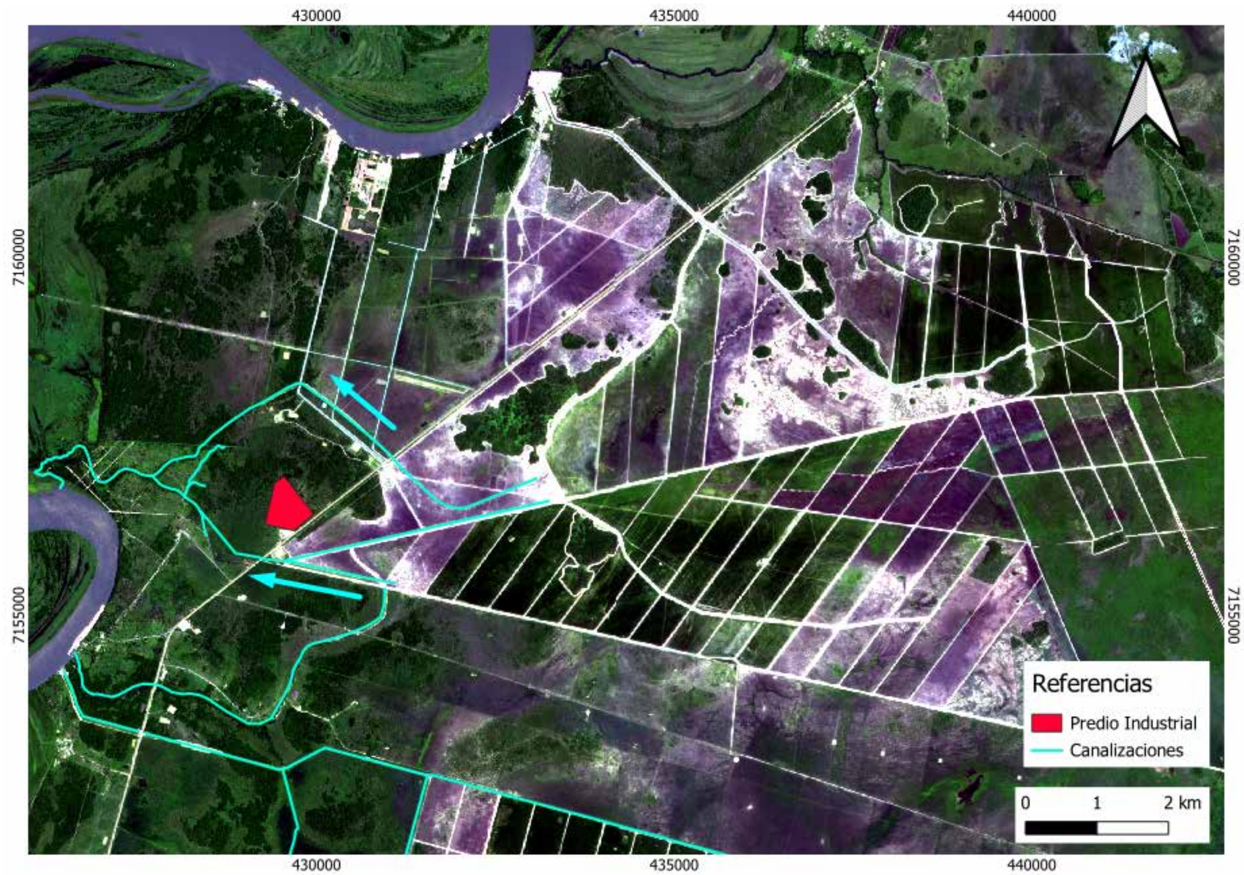

Figure 4 General runoff. Rice crops and pipelines in the area.

Independently of the existing pipes that lead the water out of the study area, three works of art (sewers) were observed on the route, whose use is probably the passage of surplus water from the southeast to the property subject to analysis.

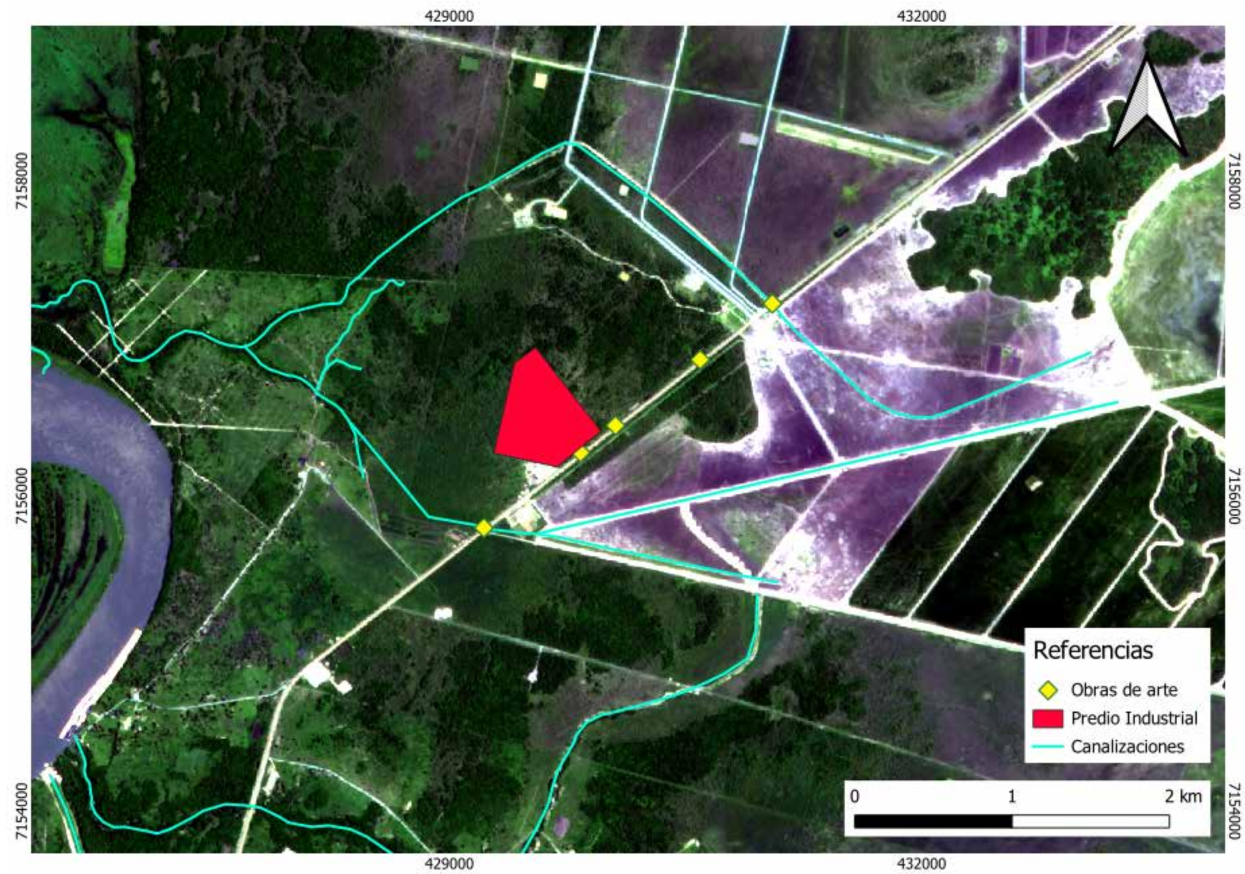

Figure 5 Location of existing artworks along the route

In addition to the existence of the works of art on the road, it is concluded that the natural drainage of the water was altered and redirected by the rice plantations, deriving the excess away from the property where the industrial property will be implanted. Under this scenario, the contribution of water on the property is practically local, that is, the rain that falls on the property itself. Another important point to mention is the fact that the route is a dam that retains part of the water on the east side, which limits the flow of water that can cross into the ATOME property.

Regarding the possible extensions of flooding of the Paraguay River, FIUNA prepared flood charts in 1996 in a project called "Zoning of Floodable Areas of the Paraguay River", as shown in the following figure.

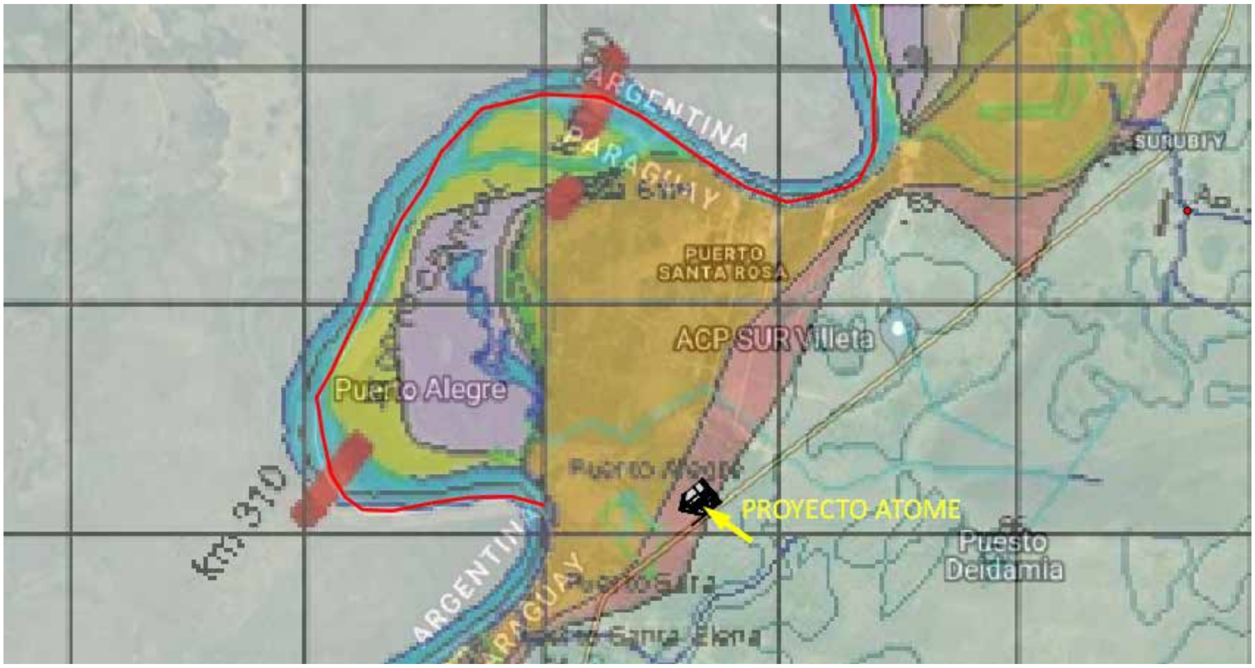

Figure 6 Flood charts in the vicinity of the industrial site (FIUNA, 1996)

The salmon color shown in the figure above symbolizes a 100-year recurrence or a 1% chance of occurrence. Although these charts are quite old, they allow you to orient yourself in the work area, concluding that the probability of flooding is low but possible. A more detailed analysis of the levels of the Paraguay River in the area of the industrial site is carried out later.

Regarding the rainfall in the area, it is characterized by practically the same regime as Asunción, given the proximity between the two cities. The Asunción rain gauge station has data from 1960 to the present, as shown in the following figure.

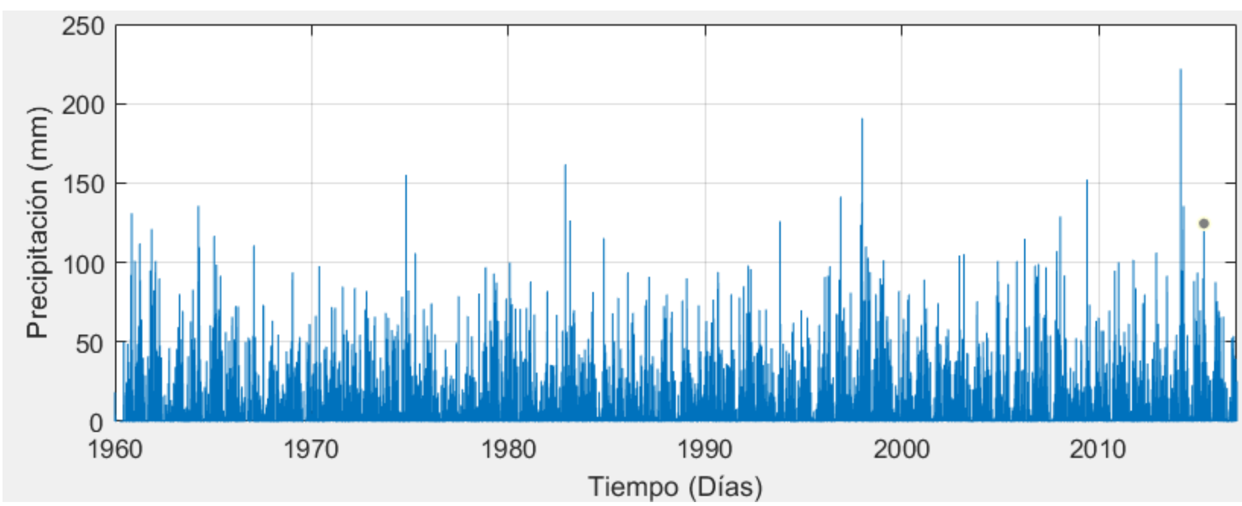

Figure 7 Historical series available from Asunción Station

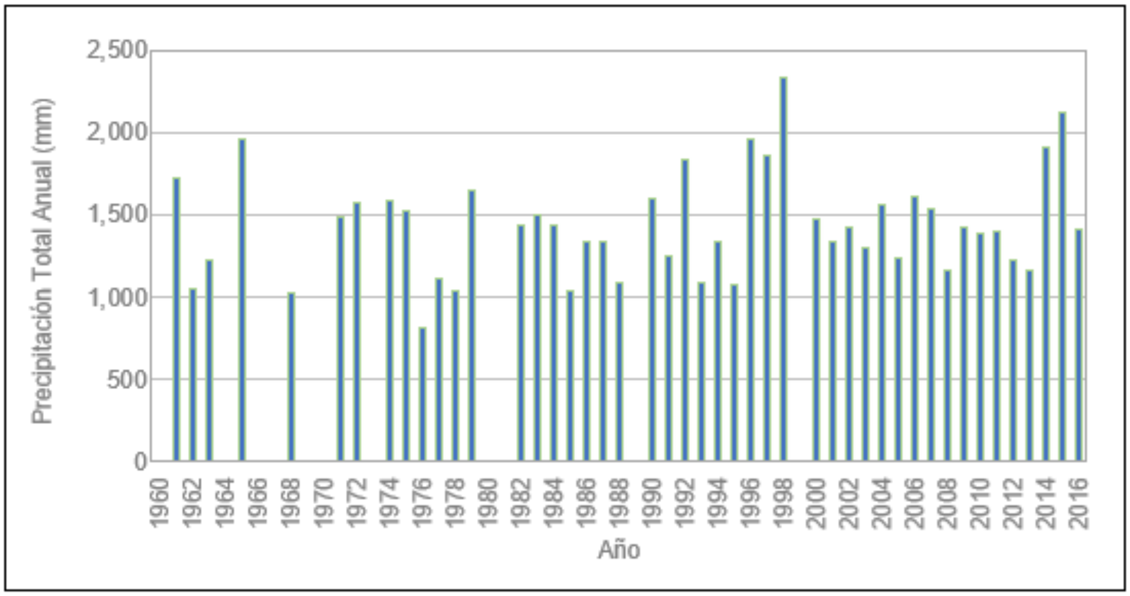

Figure 8 Annual Rainfall at Asunción Station

Based on the series of available data, it is possible to characterize the rainfall regime of the area.

It is observed that the rainfall regime has two distinct periods: October to April (WET) and May to September (DRY), with a general average of 146 mm/month and 75 mm/month, respectively.

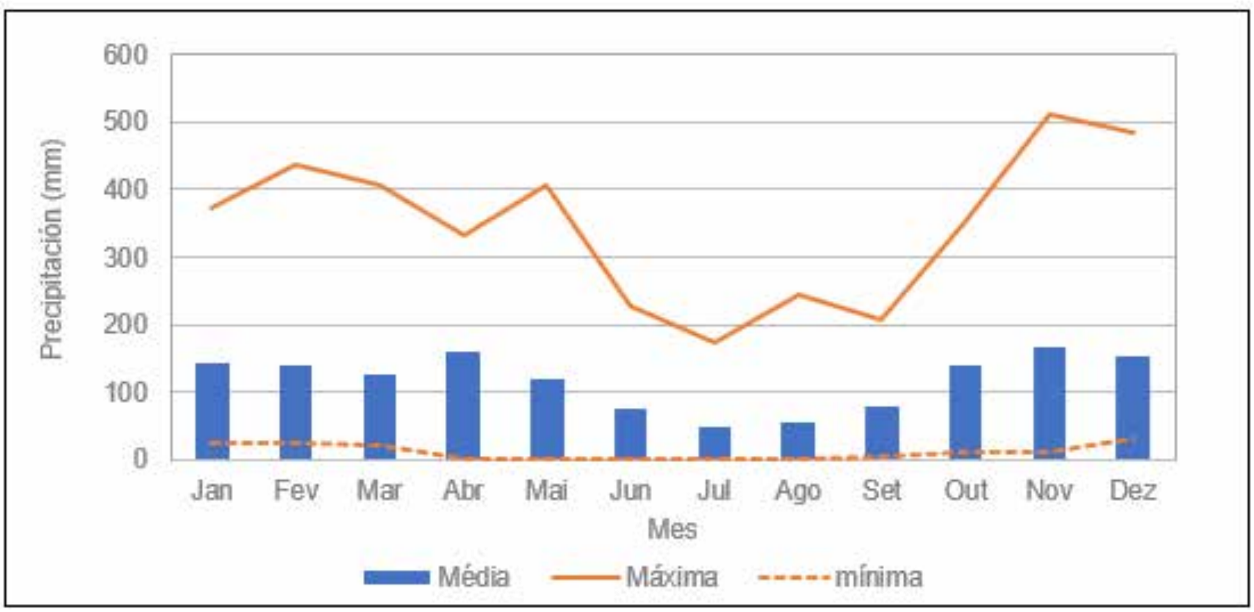

Figure 9 Total Monthly Precipitation

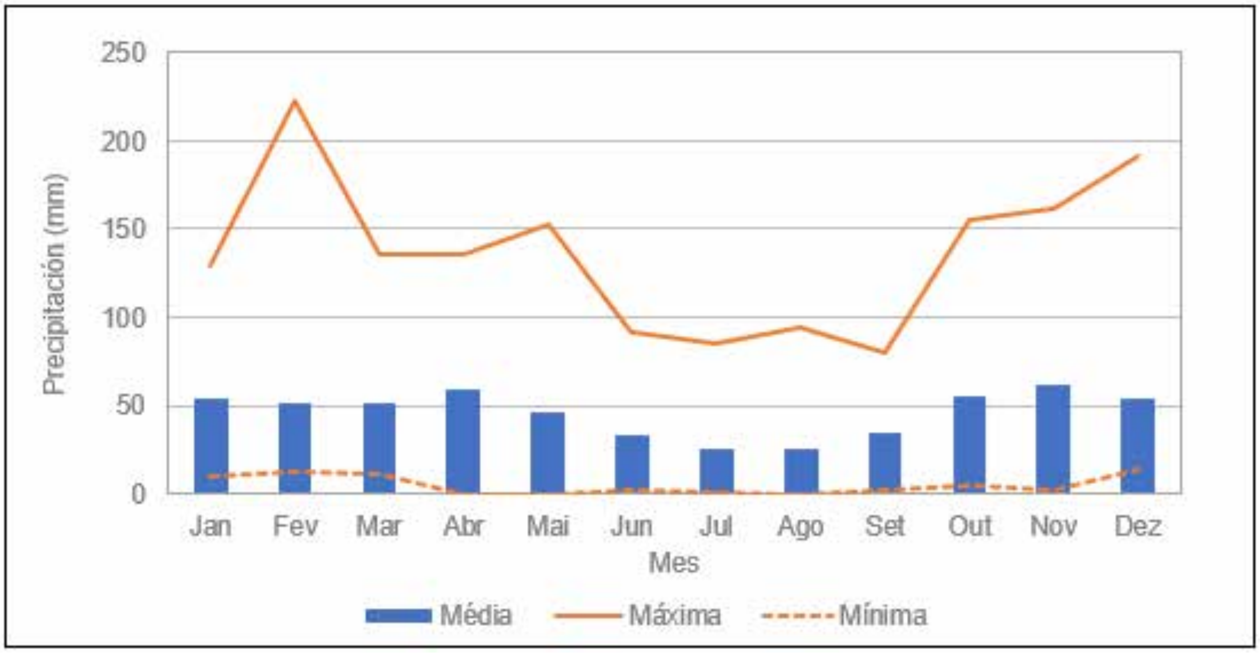

Figure 10 Monthly Daily Maximum Rainfall

Regarding the number of days with rain at the monthly level, there is evidence of a general monthly average of around 8 days.

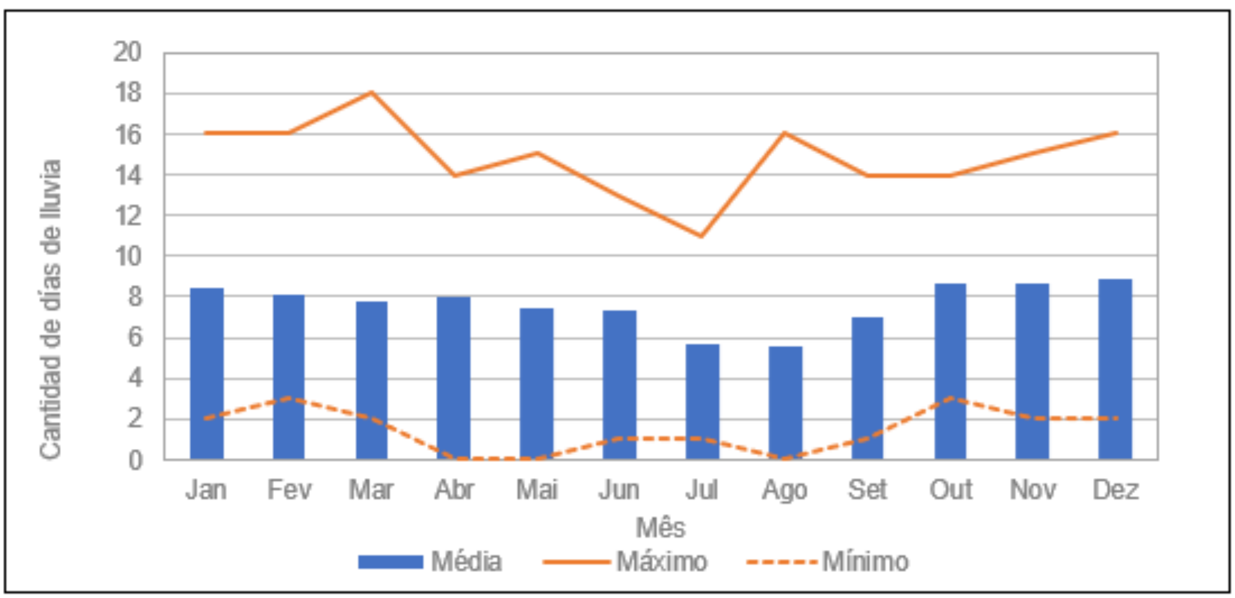

Figure 11 Number of Monthly Rainy Days

4. Evaluation of the runoff pattern

To evaluate the runoff pattern and the maximum water levels reached, the HEC-RAS hydraulic model in its 2D hydrodynamic version (two dimensions) is used. The main input of this type of model is a surface that adequately represents the relief of the area subject to analysis. This surface was obtained from an aerophotogrammetric flight, the results of which were made available for the purposes of this study.

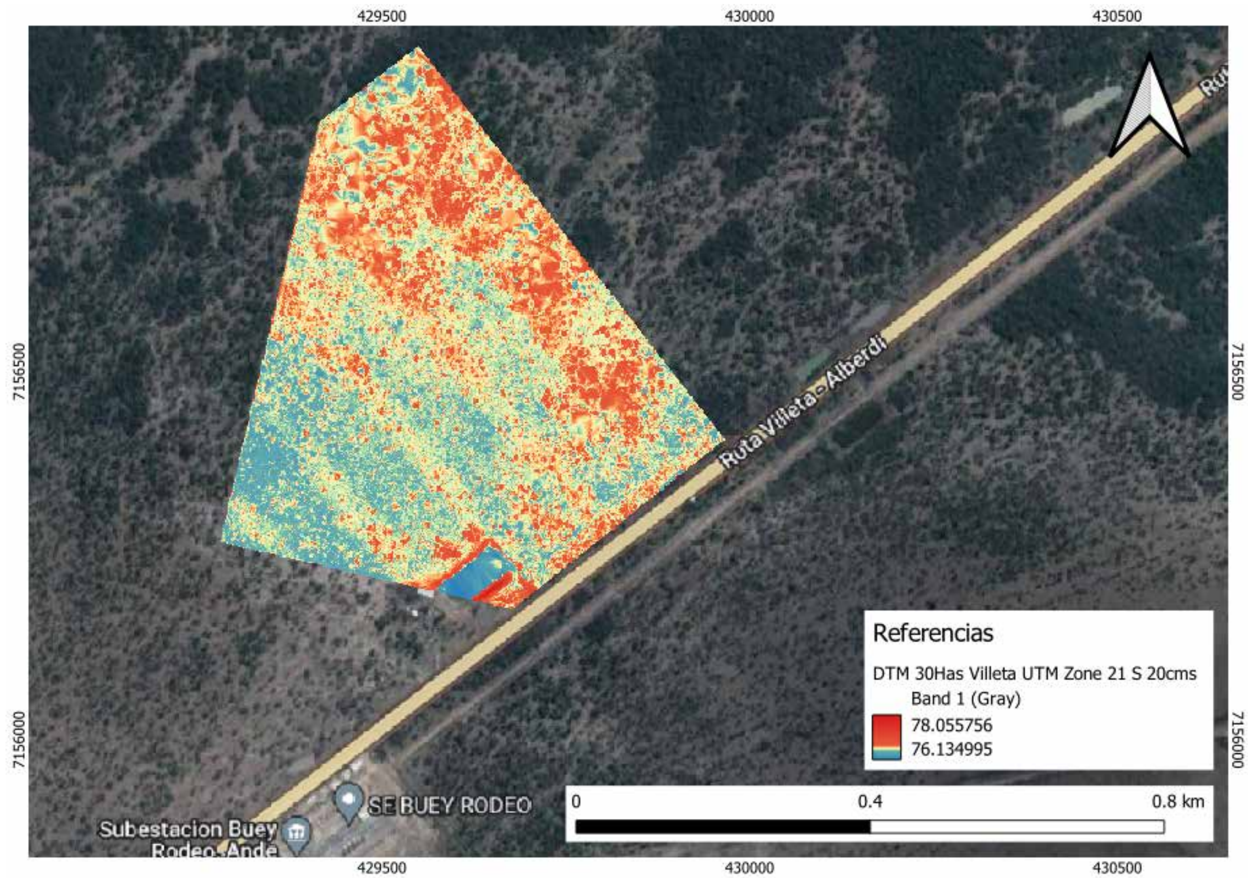

Figure 12 Digital Terrain Model. Source: Topography surveyed by the consulting firm IKE.

On the other hand, it is important to properly define the edge conditions of the model. In the case of the simulation mesh boundary, a "normal height" edge condition is adopted, which basically allows a constant slope to be assumed (in this case an extremely low slope).

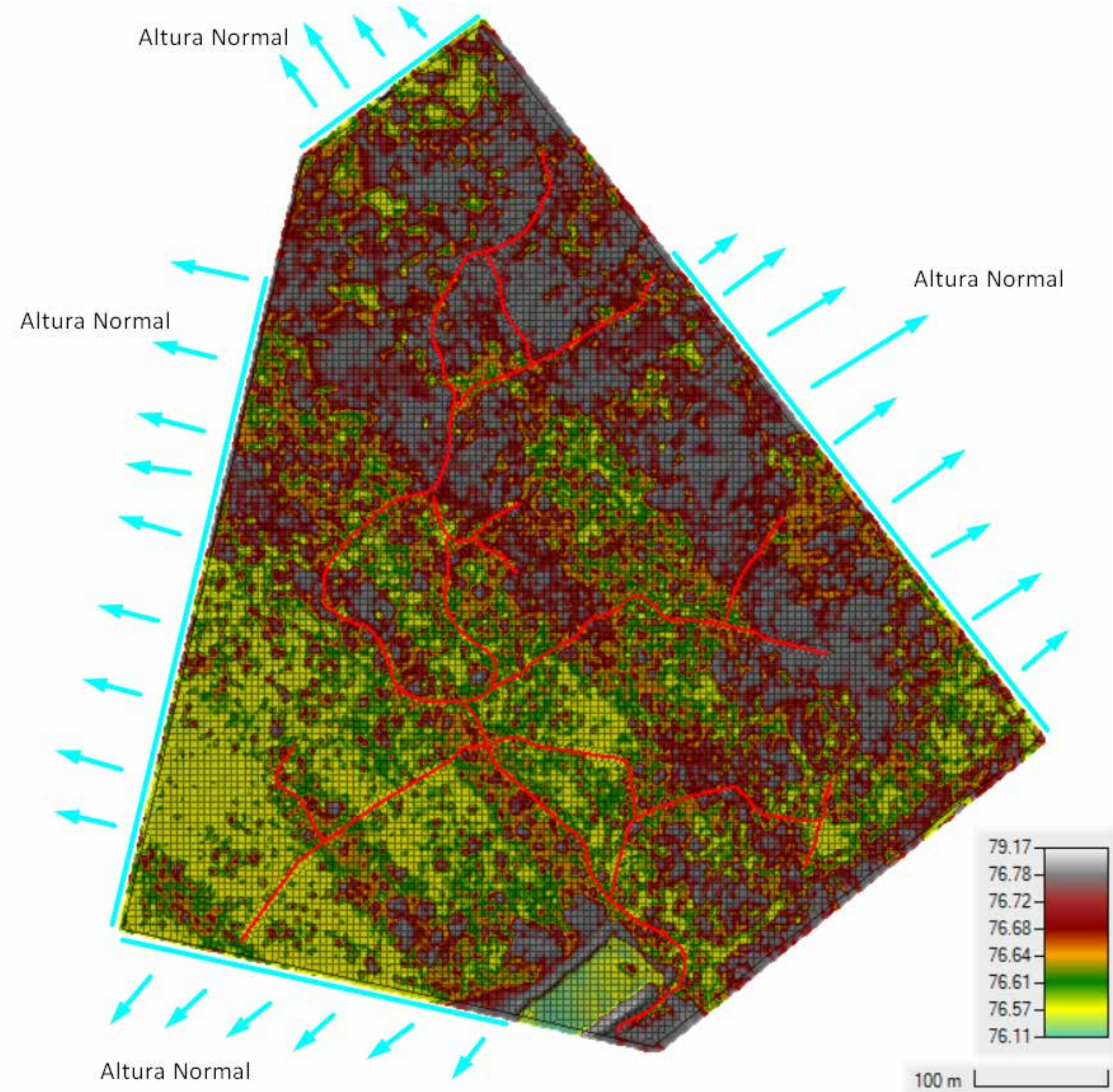

Figure 13 Edge Conditions

With respect to design rainfall, in the absence of input basins, it is decided to adopt a storm duration of 3 hours for a recurrence of 25 years (this choice is made in order to be conservative since the concentration time in flat areas is generally longer). This rainfall is generated from the IDF curves of Paraguay, particularly using the curve corresponding to the Asunción station.

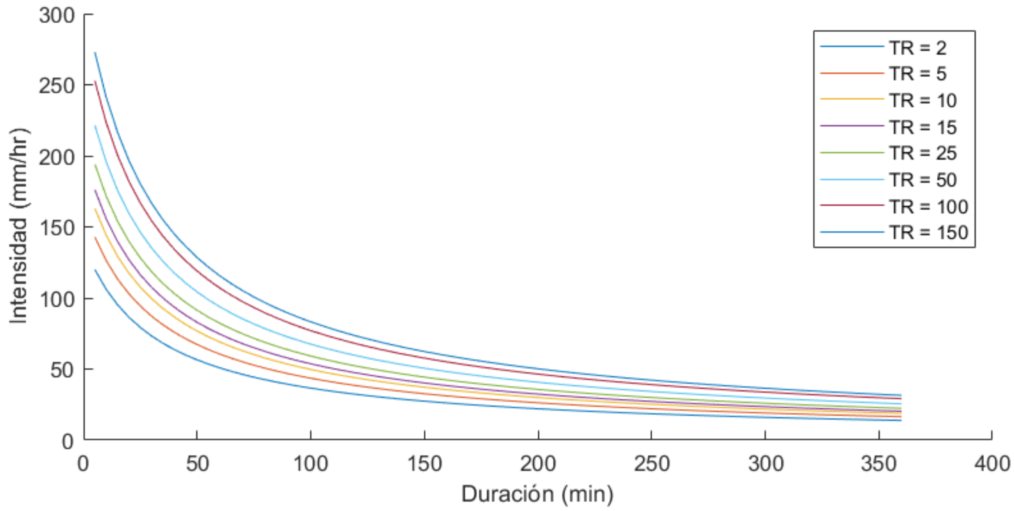

Figure 14 Asunción IDF Curves

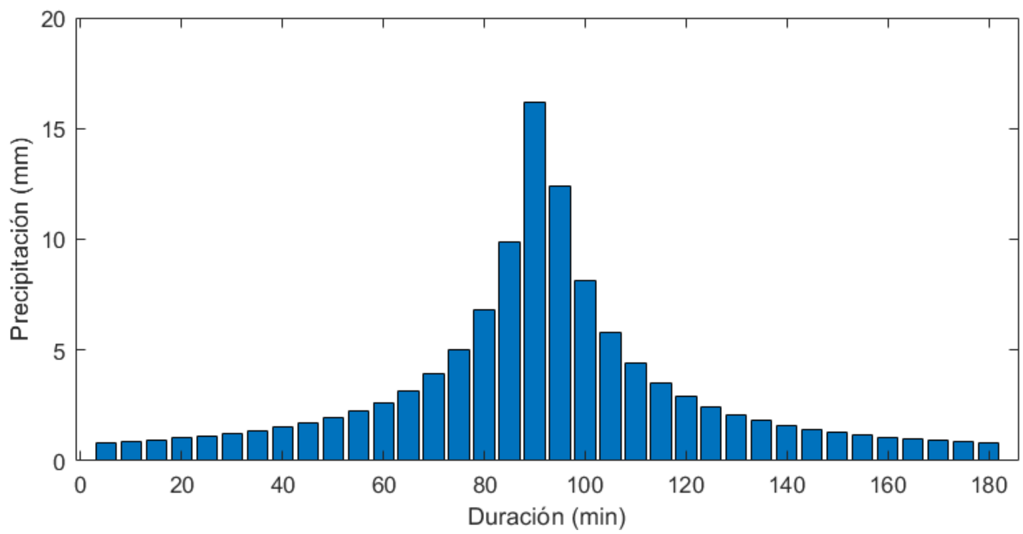

Figure 15 Design rain. 3hrs duration. 5 min interval. TR = 25 years

5. Results obtained and recommendations for water management

The results obtained show that the general pattern of runoff is to the west, which suggests that the system of perimeter canals for the drainage of rainwater from the industrial site should be in the same direction.

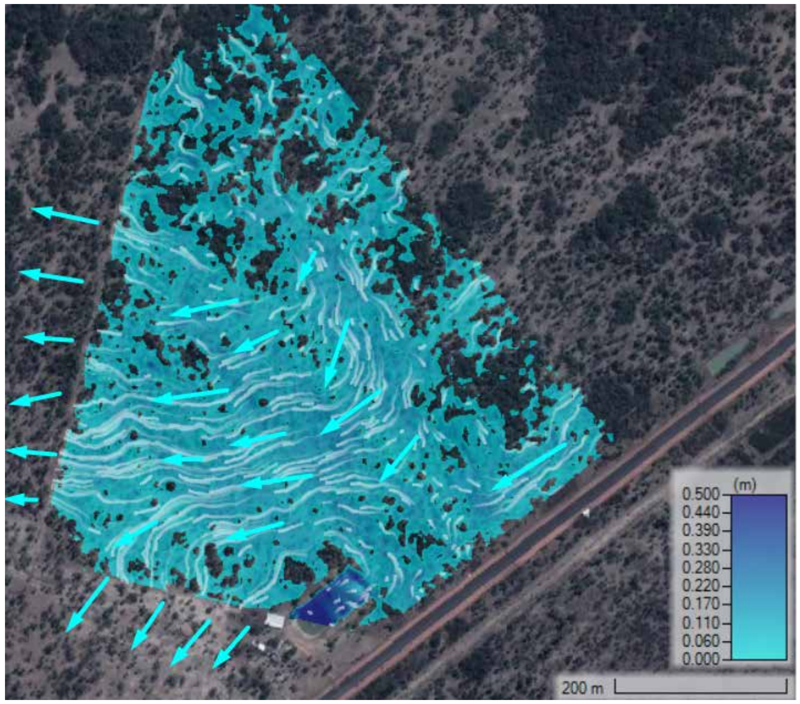

Figure 16 Runoff pattern in the study area

In addition to the direction of runoff, the water depths and the maximum water level were also analyzed, which should be used as a reference to define the shelf level.

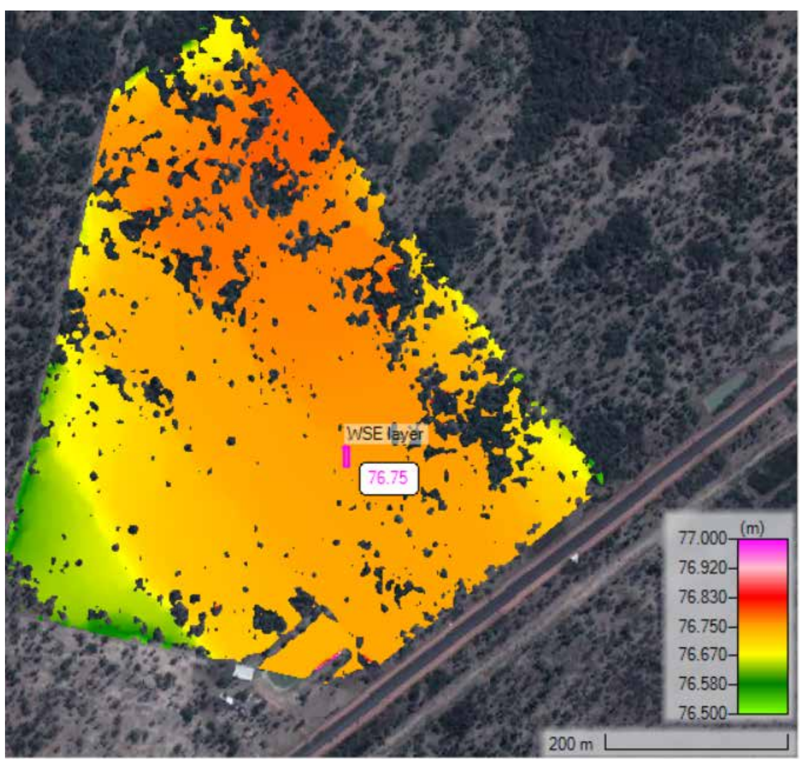

Figure 17 Maximum water level along the property

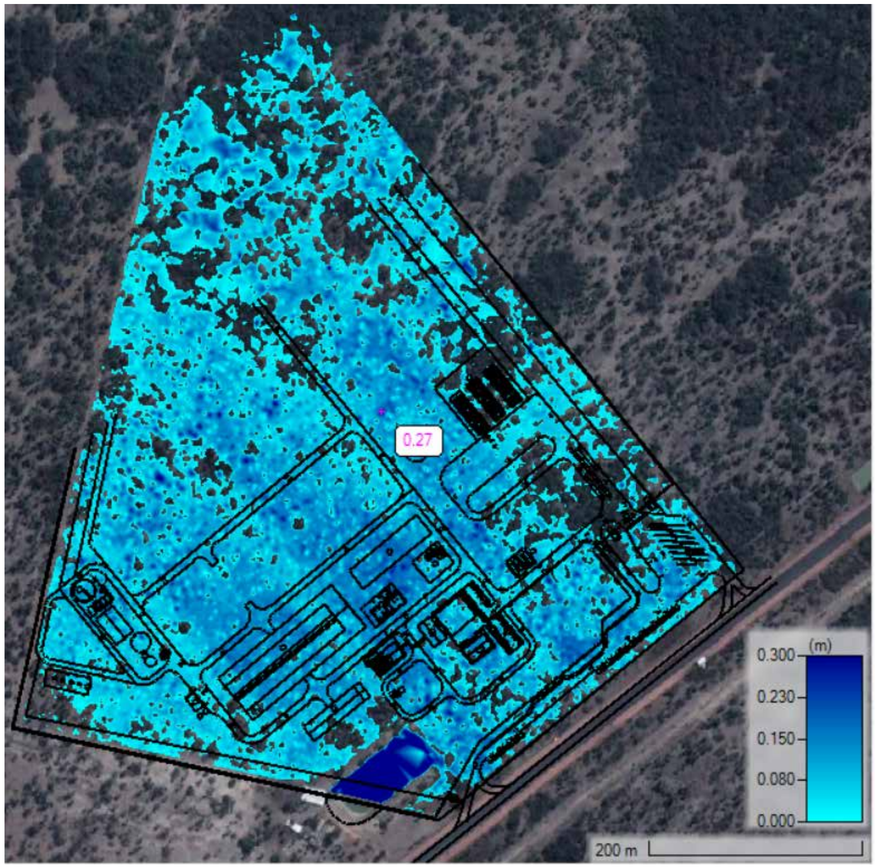

Figure 18 Water depth in the field for a rainfall with a recurrence period of 25 years

As can be seen in the figure above, the maximum depth of water on the ground would be between 25 and 30 cm for a recurrence of 25 years.

According to the maximum water level obtained (+76.80) by a rainfall of 25 years of recurrence, the suggested minimum shelf level is +77.80. It is important to mention that the drainage of the platform should have at least 0.5% to drain the water by gravity without pumping requirements.

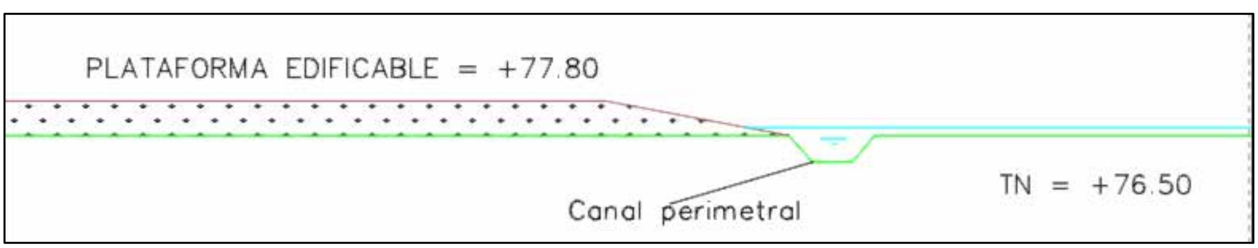

Figure 19 Suggested Building Platform

For rainwater management, it is suggested to incorporate perimeter channels that allow water to be conducted towards the channels or furrows formed by water runoff, as shown in the following figure.

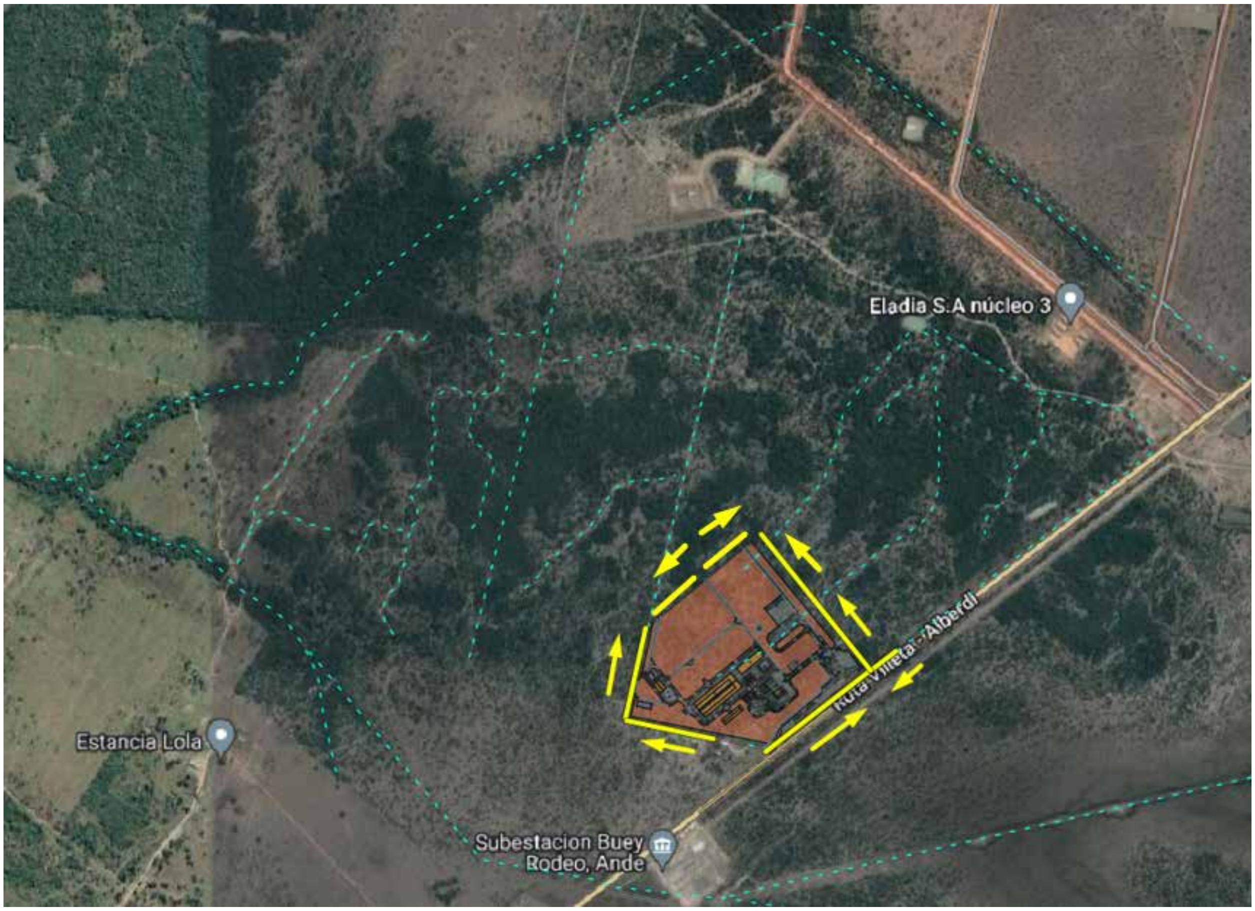

Figure 20 Perimeter channels (in yellow) and terrain flow lines in light blue

The perimeter channels could adopt a trapezoidal shape with a base of 1.00 m and a height of 1.00 m (1:1 slope). For the internal drainage of the property, it is suggested to distribute the water in two areas, as shown in the following figure.

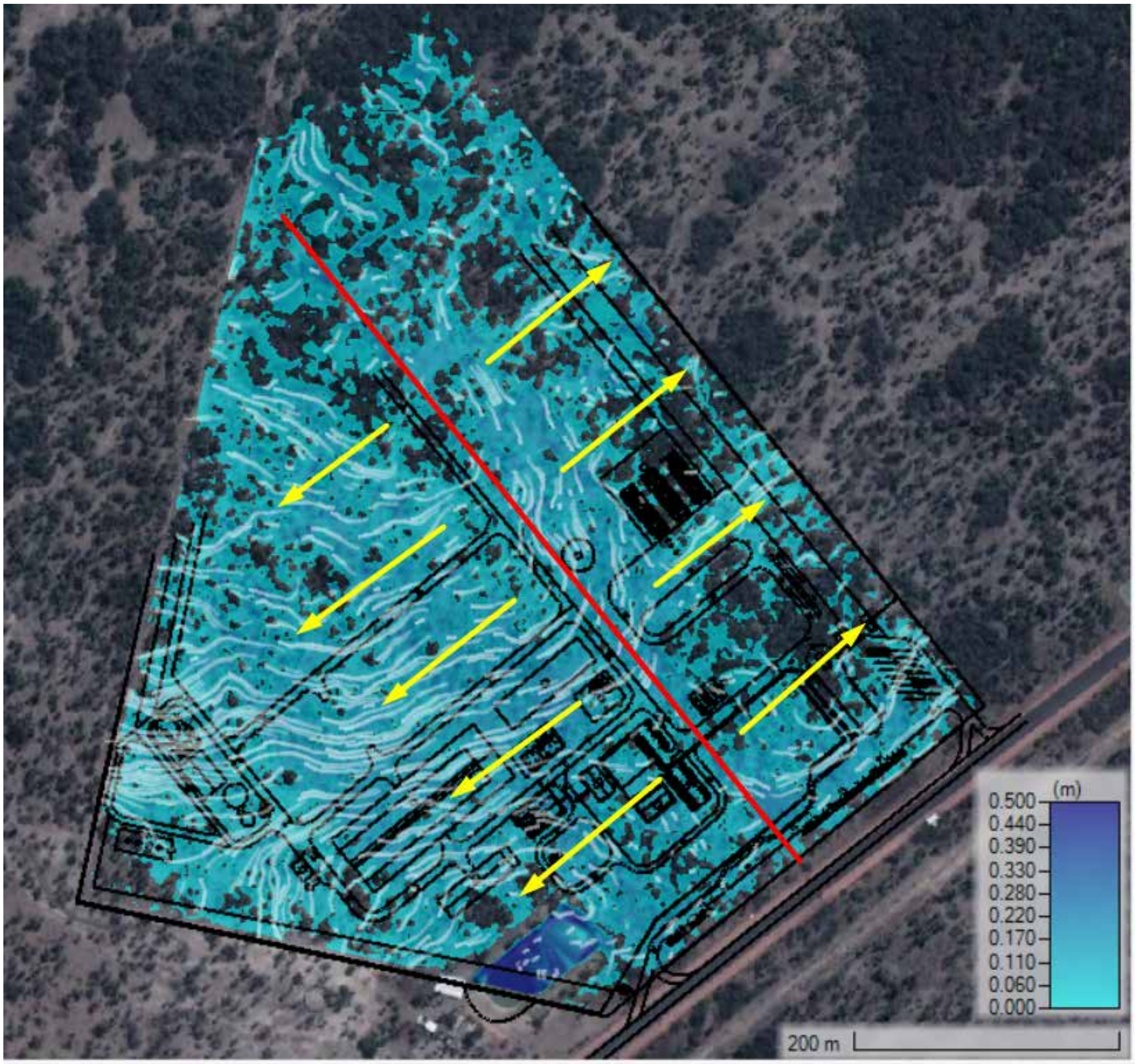

Figure 21 Concept of water distribution on the property (red line: dividing water management sectors)

6. Statistical study of the water levels of the Paraguay River in Villeta

In order to evaluate the flood zones, the level of the river in Villeta is first statistically studied. The Villeta river level data series extends from 1980 to the present (40 years of data). Although the length of the series is reasonable, it is possible to extend it using the Asunción river level series, which has data from 1904 to the present (116 years of data). To extend the Villeta series with the levels recorded in Asunción, a correlation between the two data is first sought, which is presented in the following figure.

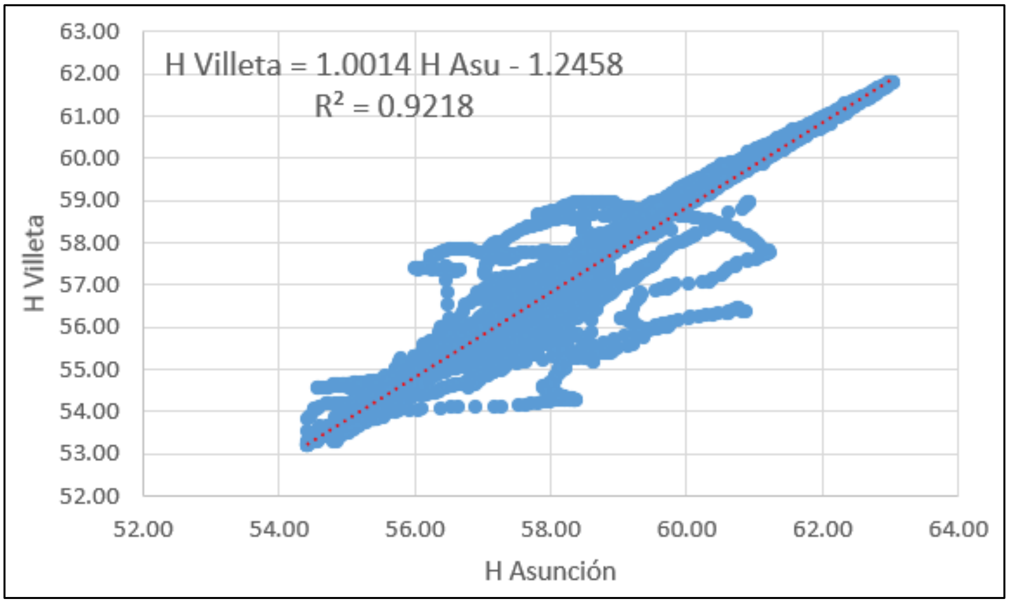

Figure 22 Correlation between Paraguay River levels in Asunción and Villeta (NMM)

Using the equation obtained in this correlation, a prolonged series of levels for Villeta is obtained, which is shown in the following figure.

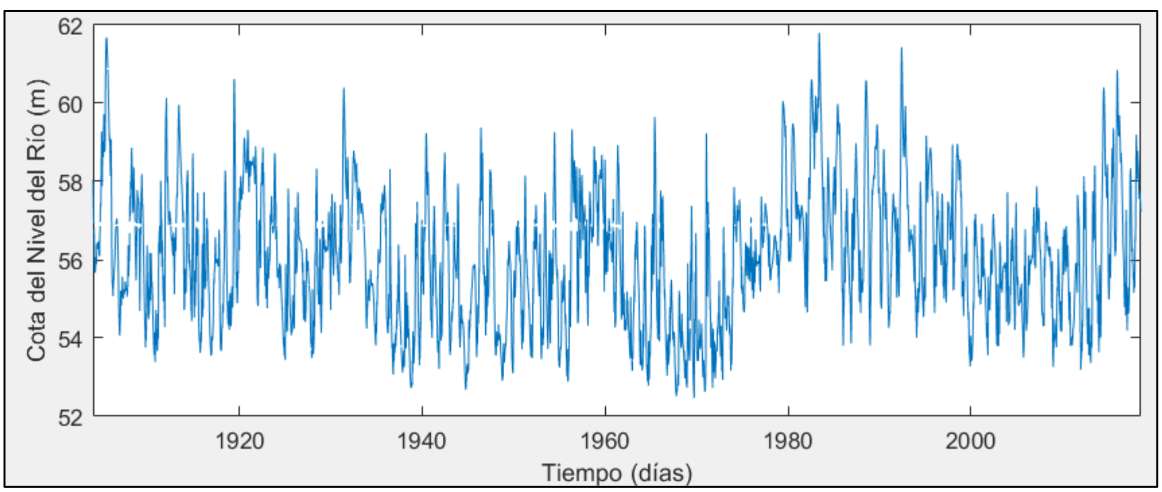

Figure 23 Extended series of levels of the Paraguay River in Villeta (NMM)

For the association of river water levels to recurrence periods, theoretical probability distributions are used.

Based on the extended series generated in the previous section, several theoretical probability distributions were used (Gumbel, Normal, Log Normal and Log Pearson Type III), and the fit of each of them was verified with the empirical distribution (observed data). The following figure shows these settings.

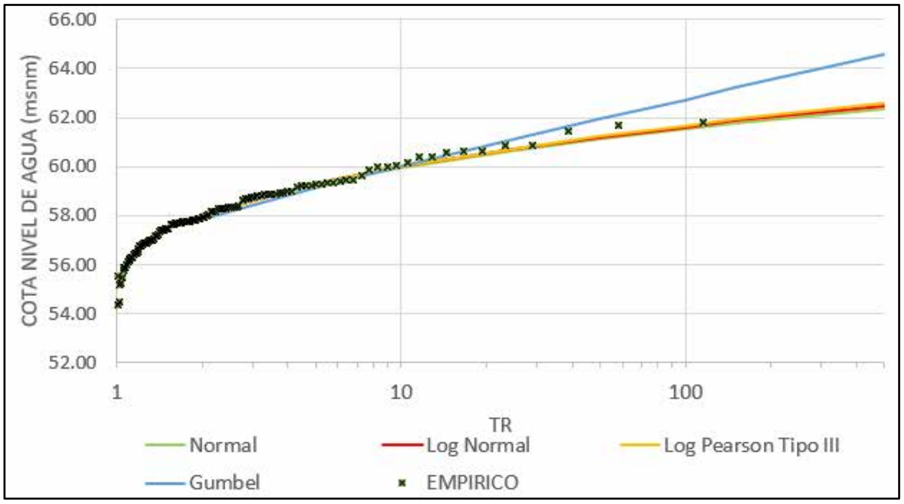

Figure 24 Theoretical Probability Distribution Adjustments (in Black Dots the Empirical Distribution) - NMM

Based on the adjustments shown in the previous figure, we chose to use the normal distribution. Finally, the values were transformed to the project datum, obtaining the following table.

Table 2 Paraguay River Levels in Villeta Associated with Recurrence Periods (adjusted for normal distribution)

TR (years)	Water Level Elevation in Villeta	Elevation of the Water Level of the Paraguay River in the area of the ATOME property
2	73.54	73.09
5	74.79	74.34
10	75.45	75
25	76.14	75.69
50	76.59	76.14
100	77	76.55
150	77.26	76.81
500	77.82	77.37

From the series of available data, the maximum level recorded in the Villeta rule is 8.94 m (on 30/05/1983), which translates to a height of +77.27 in the Project datum (Guyrati). Moving this level to the vicinity of the ATOME property, which is located 50 km downstream from Villeta, a delta H of approximately 45 cm is estimated, corresponding to a maximum water level of +76.82 in the project datum for this area. As can be seen in the table above, this maximum recorded limit corresponds to a recurrence of approximately 150 years.

Regarding the general behavior of the Paraguay River in the vicinity of the ATOME property, the following figure shows the permanence of levels in this area.

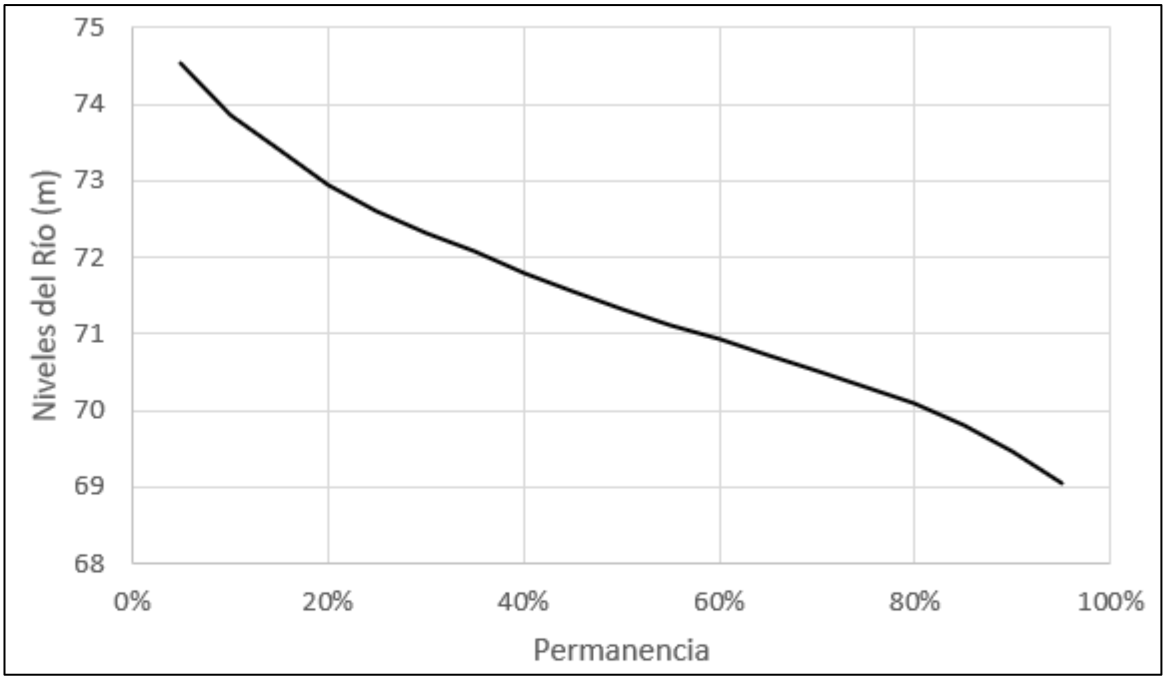

Figure 25 Permanence of levels

As can be seen in the dwell curve in the figure above, values above 76 m occur less than 1% of the time.

7. Assessment of possible effects of climate change on entrepreneurship

Climate change, or rather, the effects associated with climate change, could have an impact on the expected rainfall and river regime in the project area. In view of this, the latest projections available in international literature are used to assess whether the effects of climate change could require an adaptation of the infrastructure works of the hydrogen and green ammonia producing industry.

7.1 Temperature and Precipitation Trends due to the Effects of Climate Change

Regarding temperature projections, the most recent study is the one carried out by Lovino et al (2021).[2] This study presents upward temperature and precipitation projections for almost all scenarios. In this study, the so-called RCP (Representative Concentration Trajectories) are no longer used, but rather the new nomenclature used, which would be the SSP (Shared Socio-Economic Trajectories). The study

[2] Evaluation of historical CMIP6 model simulations and future projections of temperature and precipitation in Paraguay

considered three integrated scenarios of socio-economic development and greenhouse gas emissions: SSP1-2.6; SSP2-4.5 and SSP5-8.5.

In general terms, Lovino's (2021) study evaluated the ability of the 19 climate models of the CMIP6 (Coupled Model Intercomparison Phase 6) to simulate Paraguay's future climate.

Temperature Trend

For the most conservative scenario (SSP1-2.6), an average increase of 1.7 °C is estimated.

For the intermediate scenario (SSP2-4.5) an average increase of 3 °C is estimated.

For the worst-case scenario (SSP3-8.5), an average increase of 5.5 °C is estimated.

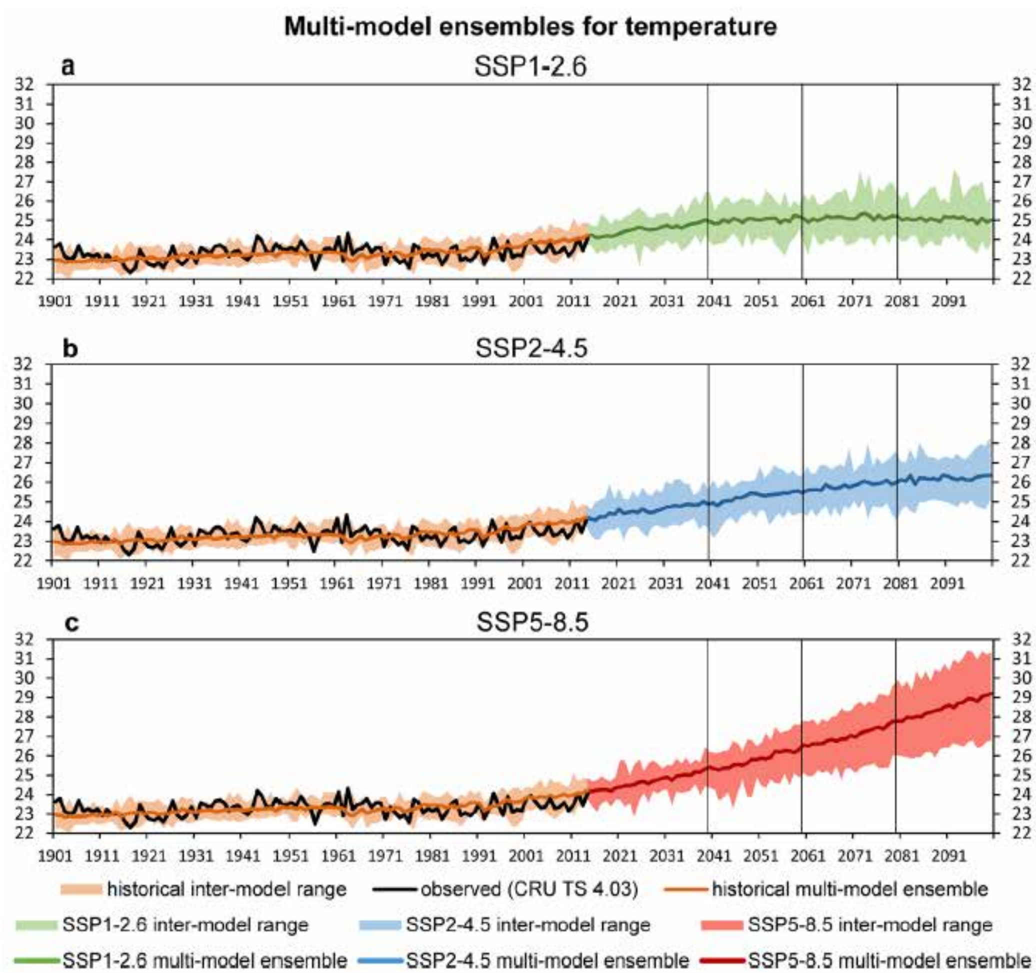

Figure 26 Average temperature trend over the next 80 years *(Lovino, 2021)*

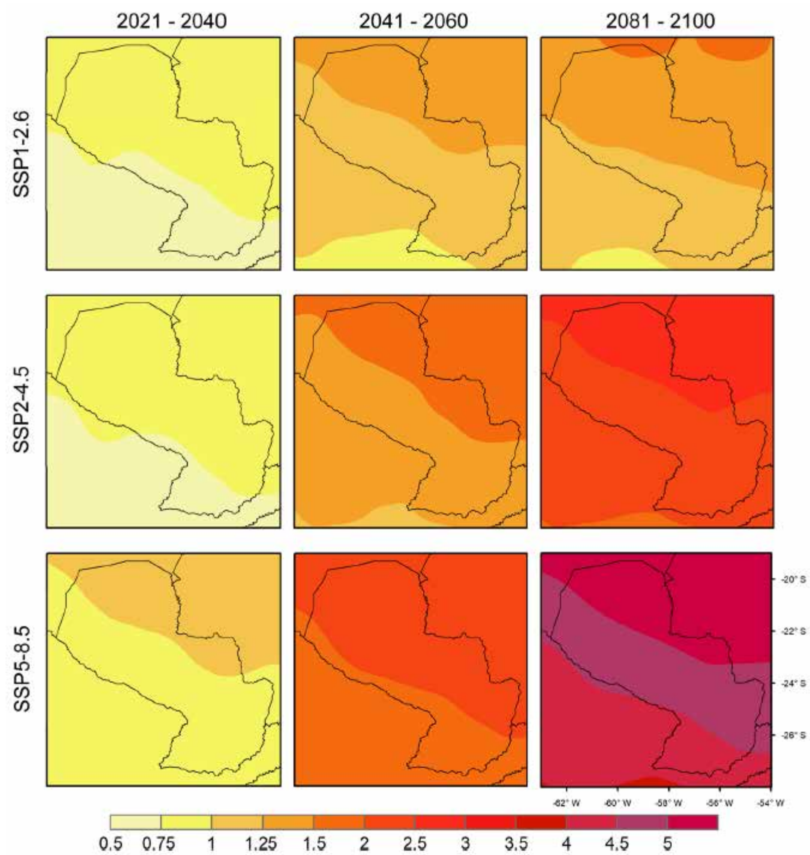

Figure 27 Spatial distribution of mean annual temperature change for different scenarios over 20-year intervals (Lovino, 2021)

Regarding extreme temperature values, a study called "Flood Risks in Bañados de Asunción – Effects of Climate Change" (IDB, 2023) is used as a reference. This study shows an overall increase in both maximum and minimum temperatures.

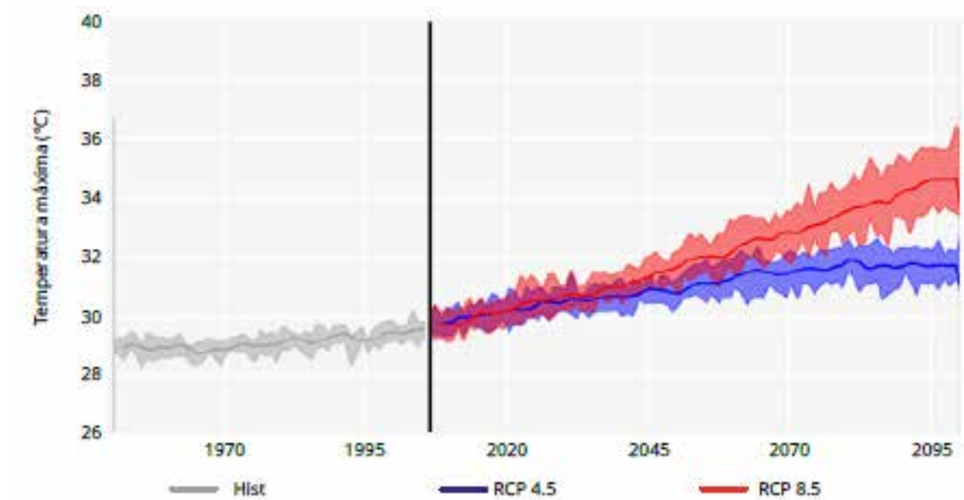

Figure 28 Maximum temperature trend in Asunción

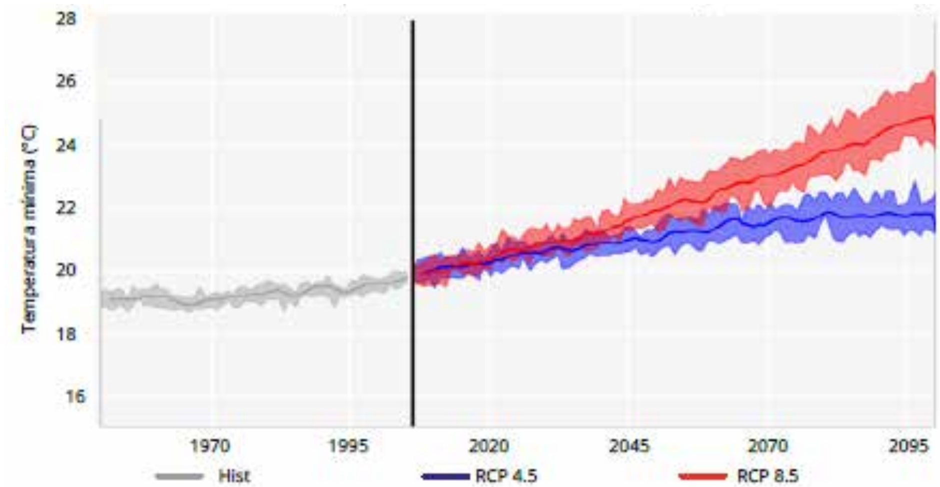

Figure 29 Minimum temperature trend in Asunción

Table 3 Summary of the variation of maximum and minimum temperatures for two emission scenarios

CPR 4.5	CPR 8.5
* For the period 2011 - 2040	
the change in the maximum temperature is +0.91 °C and +0.97 °C for the minimum temperature	the change in the maximum temperature is +0.99 °C and +1.11 °C for the minimum temperature
* For the period 2041 - 2070	
the change in the maximum temperature is +0.70 °C and +1.01 °C for the minimum temperature	the change in the maximum temperature is +2.08 °C and +2.10 °C for the minimum temperature
* For the period 2071 - 2100	
the change in the maximum temperature is +1.34 °C and +1.53 °C for the minimum temperature	the change in the maximum temperature is +2.8 °C and +3.2 °C for the minimum temperature

Precipitation Trend

The ensemble model (CMIP6) estimates a slight decrease in precipitation to the northwest (less than 50 mm) and an increase to the southeast (more than 200 mm).

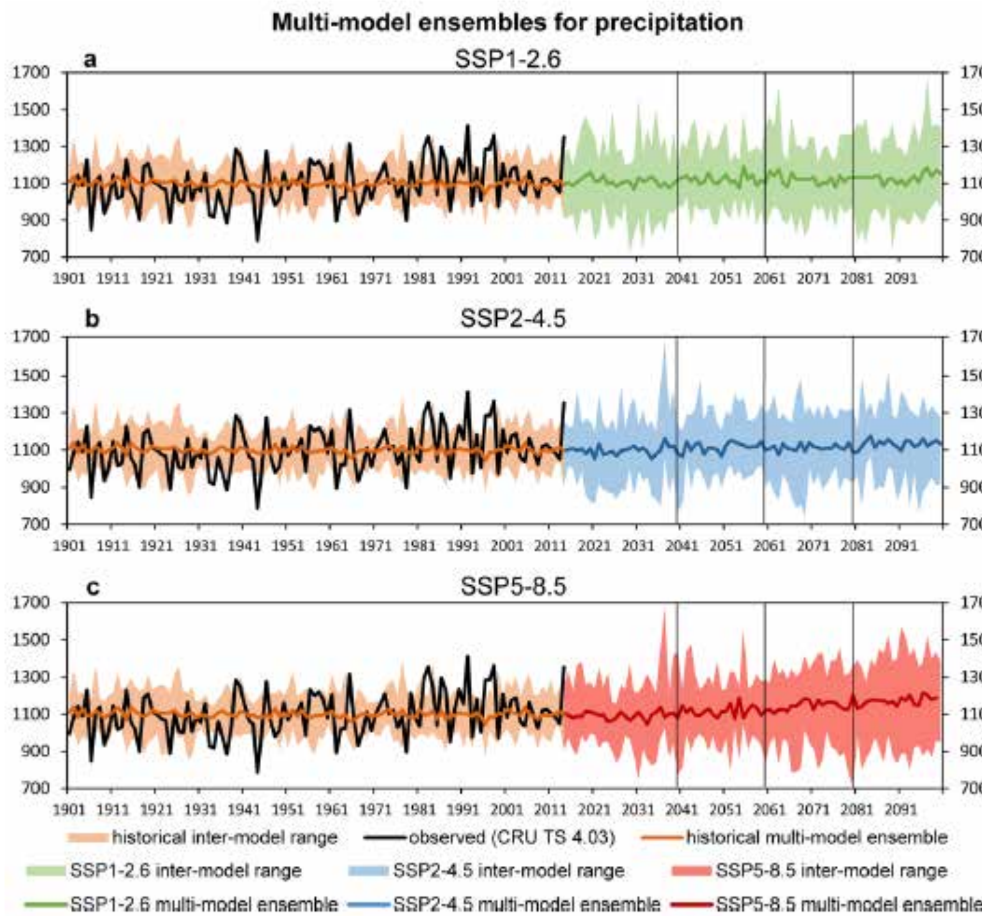

Figure 30 Trend of average annual precipitation over the next 80 years (Lovino, 2021)

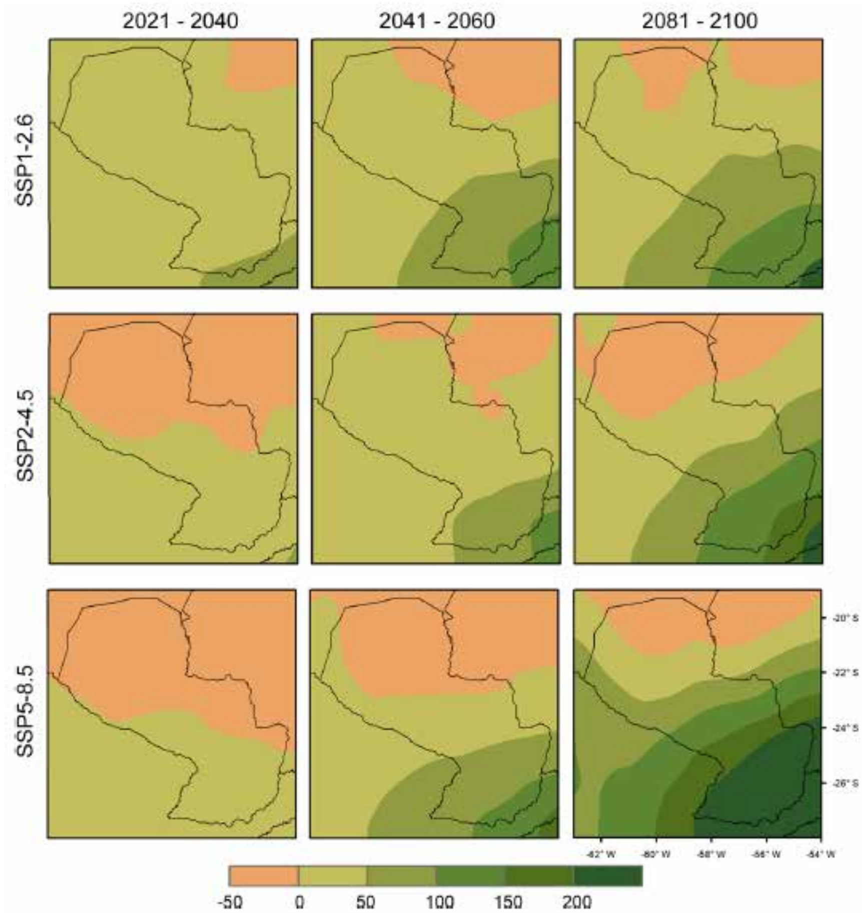

Figure 31 Spatial distribution of the change in mean annual precipitation for the different scenarios over a 20-year interval (Lovino, 2021)

With regard to maximum precipitation, intensity, duration and frequency curves (IDF curves) are used in the design of hydraulic works. These curves are used to estimate synthetic rainfall to model the behavior of hydraulic works in the face of extreme events associated with a specific recurrence period. The Bañados de Asunción Flood Risk Study (IDB, 2023) estimated the variation of these IDF curves for two emission scenarios at 30-year intervals, up to the year 2100. A summary of the results obtained is shown in the table below.

Table 4 Summary of the Variation Factors of the Asunción IDF Curves

T (PERIODO DE RETORNO)	RCP 4.5 2011-2040	RCP 4.5 2041-2070	RCP 4.5 2071-2100	RCP 8.5 2011-2040	RCP 8.5 2041-2070	RCP 8.5 2071-2100
2	1.08	1.15	1.03	1.03	1.10	1.12
5	1.07	1.16	1.03	1.04	1.18	1.11
10	1.05	1.15	1.02	1.06	1.22	1.12
25	1.03	1.13	1.01	1.11	1.25	1.13
50	1.01	1.11	1.00	1.15	1.27	1.14
100	0.99	1.09	1.00	1.20	1.29	1.15
200	0.97	1.07	0.99	1.26	1.30	1.16
500	0.96	1.05	0.99	1.35	1.32	1.18

For the present study, the IDF curve of Asunción was adopted as an input for the design of works and flood study, so it is considered appropriate to use the previous table as an indicator to evaluate the future increase in a very unfavorable scenario.

As shown in the table above, the maximum increase for the recurrences of construction design (10, 25, 50 and 100 years) is given for the RCP 8.5 scenario in the period 2041-2070, estimating an increase of approximately 30%. This increase is not considered very significant in terms of the design of works, since they are sized with a certain slack capable of accepting a certain additional flow. To get an idea of the magnitude of the increase, the following figure shows a comparison of two hyetograms, one of them was prepared from the current IDF curve and the other corresponds to the percentage increase of 30% for the RCP 8.5 scenario.

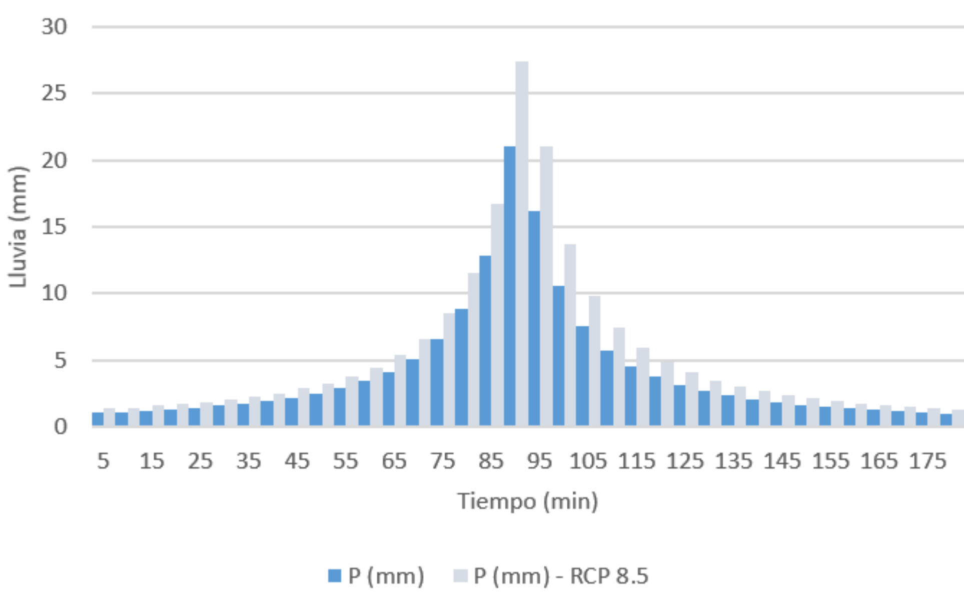

Figure 32 Comparison of a 3-hour hyetogram with the current IDF curves vs. a hyetogram associated with the RCP 8.5 scenario (+ 30%)

As seen in the figure above, the 30% increase is only 6 mm of additional rain for the peak of the storm. In terms of total volume, the difference is approximately 40 mm. This increase is insignificant for a flat and extensive property, where water can spread considerably. In this case, the adoption of the rainfall corresponding to the RCP 8.5 scenario in the hydrodynamic model results in an increase of only 1cm in the water level, as a result of the large water spread area that exists in the area.

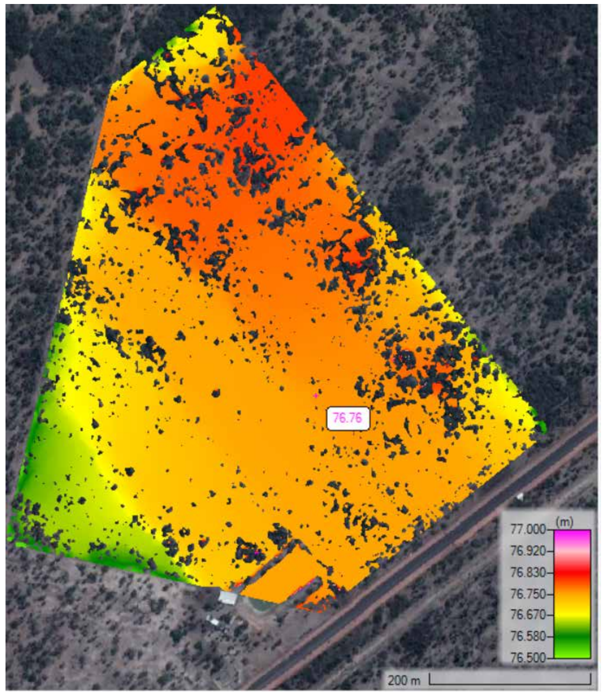

Figure 33 Maximum water level along the site for an 8.5 RCP scenario

Trend in the variation of the levels of the Paraguay River

Water levels in the Paraguay River could also vary in the coming decades as a result of regional rainfall projections. The Flood Risk Study in the Bañados de Asunción (IDB, 2023) estimated variations in the maximum water levels of the Paraguay River for different recurrence periods. For all the recurrence periods analysed, a decrease in maximum levels is estimated, so an increase in the risk of river flooding in the project area is considered unlikely.

Table 5 Summary of the variation of the maximum water levels of the Paraguay River in Asunción

T (PERIODO DE RETORNO)	2011-2040	2041-2070	2071-2100	PERIODO DE REFERENCIA
2	57.69	58.36	59.06	59.18
5	59.05	59.72	60.39	60.51
10	59.72	60.43	61.10	61.22
25	60.51	61.15	61.82	61.94
50	60.95	61.59	62.26	62.38
100	61.31	61.96	62.63	62.75
200	61.62	62.27	62.94	63.06
500	61.95	62.60	63.27	63.40

Note: *although the estimation of levels in the previous table corresponds to the city of Asunción, it is important to mention that there is a strong correlation between the levels in Asunción and Villeta, so it is considered appropriate to use this table as a reference.*

Availability of water for industrial use

Regarding the use of the plant's water, according to available data, it is estimated that the river water will be collected in the order of 243 m3/hr, returning approximately 77 m3/hr (with a peak of 84 m3/hr) after treatment. For reference, the most severe drought of the Paraguay River in the period from 1904 to the present corresponds to -0.70 m of the hydrometric rule of Asunción. In 2020, the flow associated with the -0.45 m level of the rule was measured, recording 970 m3/s.

Taking into consideration the minimum flow measured for -0.45 in the rule, the extreme drought level of -0.70 could be associated with an approximate flow of 600 m3/s, which would be approximately 2,160,000 m3/hr.

The flow that will be extracted from the river for the operation of the plant represents 0.0125% of the minimum flow associated with an extreme drought event. Based on these numbers, it is acceptable to conclude that there would be practically no impact on the Paraguay River, since the plant's consumption is negligible in relation to the availability of water in the most extreme case of low water.

8. Conclusions and Recommendations

The present study resulted in maximum water levels associated with extreme rainfall and river events. In both cases, an approximate water level of +76.80 was obtained. Based on this, it is recommended that the industry platform dimension be set at +77.80.

In addition, possible effects of climate change were evaluated, which resulted in a negligible increase in water level due to the 30% increase in extreme rainfall associated with the worst-case scenario RCP 8.5.

Regarding the need to extract water from the Paraguay River for industrial use, in the order of 243 m3/hr, it is considered insignificant in terms of impact on the body of water, considering the flow module of the Paraguay River. By way of reference, the most severe low water of the Paraguay River in the period from 1904 to the present corresponds to -0.70 m, associated with an approximate flow of 600 m3/s, which would be approximately 2,160,000 m3/hr. It is advisable to study water quality for different water availability scenarios, which was outside the scope of this study.

APPENDIX A- TOPOGRAPHIC STUDY OF ELEVATION LINKAGE

VINCULACION DE DATUM VERTICAL PUNTO 100056 GUYRATI A NMM REGLA HIDROMETRICA DE VILLETA

Se ha realizado una vinculación del punto de la red Geodésica Nacional con el nivel Medio del Mar de la regla Hidrométrica del Puerto de Villeta.

En primera instancia, se procedió a la verificación de las coordenadas partiendo del Punto de Primer Orden de la Red Geodésica del Paraguay **100056 Guyrati**, cuya coordenadas UTM -WGS84 N: 7.170476,537; Este 443.061,765 y Cota 87,47 desde el cual se procedió a realizar la lectura a la referencia de nivel denominado **"REGLA VILLETA"** que se encuentra en el Puerto de Villeta por el método RTK, además se tomaron los niveles del pelo de agua en las inmediaciones de la regla y la base de la segunda regla en fecha 07-09-2023.

En las planillas que se muestran a continuación las coordenadas de los puntos relevados, así como las fotografías del trabajo realizado.

Datos del archivo del proyecto				Sistema de coordenadas		
Nombre: 100056 Guyrati	Nombre:				World wide/UTM	
ıaño:	Zona:				21 South	
a horaria:	Datum de referencia global:				WGS 1984	
ıcripción:	Geoide:				EGM96 (Global)	
Lista de Puntos						
Nombre	Norte (Metro)	Este (Metro)	Elevación Elipsoidal	Elevación EGM96	Elevación NMM	Código de característica
100056GUYRATI	7.170.476,537	443.061,765	87,470	70,390	72,003	GUYRATI 1992 DSGM
100056MR1	7.170.446,963	443.058,962	87,980	70,900	72,513	GUYRATI MR1 1992 DSGM
0.00 regla Villeta	7.179.023,451	442.184,789	68,327	51,247	52,860	Base de la Regla
3.00 regla villeta	7.178.936,770	442.167,787	71,326	54,246	55,860	Base de la Regla
2	7.179.023,451	442.184,789	70,777	53,697	55,310	pelo agua regla 2.45
1	7.178.942,954	442.166,503	70,758	53,678	55,290	pelo de agua frente regla 3.00
7/9/2023 15:00						

Ing. Sandro Rafael Fernández Ruiz
Reg. MOPC 1742

EQUIPOS UTILIZADOS

Los trabajos topográficos fueron ejecutados con instrumentos modernos GPS - L1&L2, TRIMBLE R8S diferencial, con post procesamiento y Software Trimble Business Center. La precisión horizontal fue de 0.004 metros y la precisión vertical fue de 0.005 metros al Punto RN10.

GNSS Trimble R8s GNSS

- Medidas de fase portadora GNSS de muy bajo ruido con una precisión <1 mm de en un ancho de banda de 1 Hz

Horizontal . . . . .8 mm + 0,5 ppm RMS

Vertical . . . . 15 mm + 0,5 ppm RMS

Tiempo de inicialización5. . . . . Típico de >99,9%

- Receptor Base - Receptor Rover (Móvil) - Bastón de 2m de fibra de carbono - Estuche de plástico de transporte
- Controladora TSC3 - Radio TDL450- Software de Gabinete Trimble Business Center

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Fotografías

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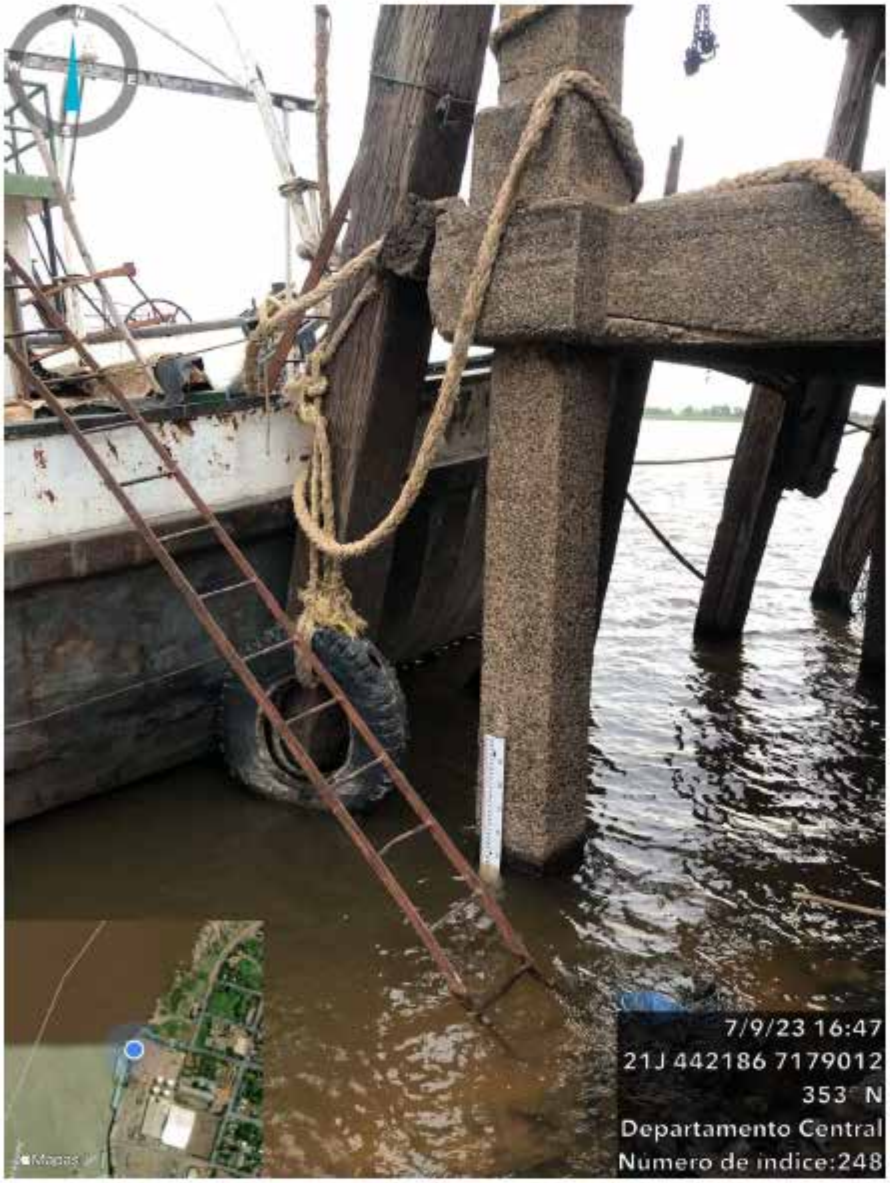

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Annex 4 – Air Quality Modelling Report

Air Quality Modelling

March 2024

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1. Introduction

An assessment was made of the potential impact on air quality due to the future operation of ATOME's green hydrogen, ammonia, and fertiliser production plant, which will be installed in the district of Villeta in the Central Department of the Republic of Paraguay.

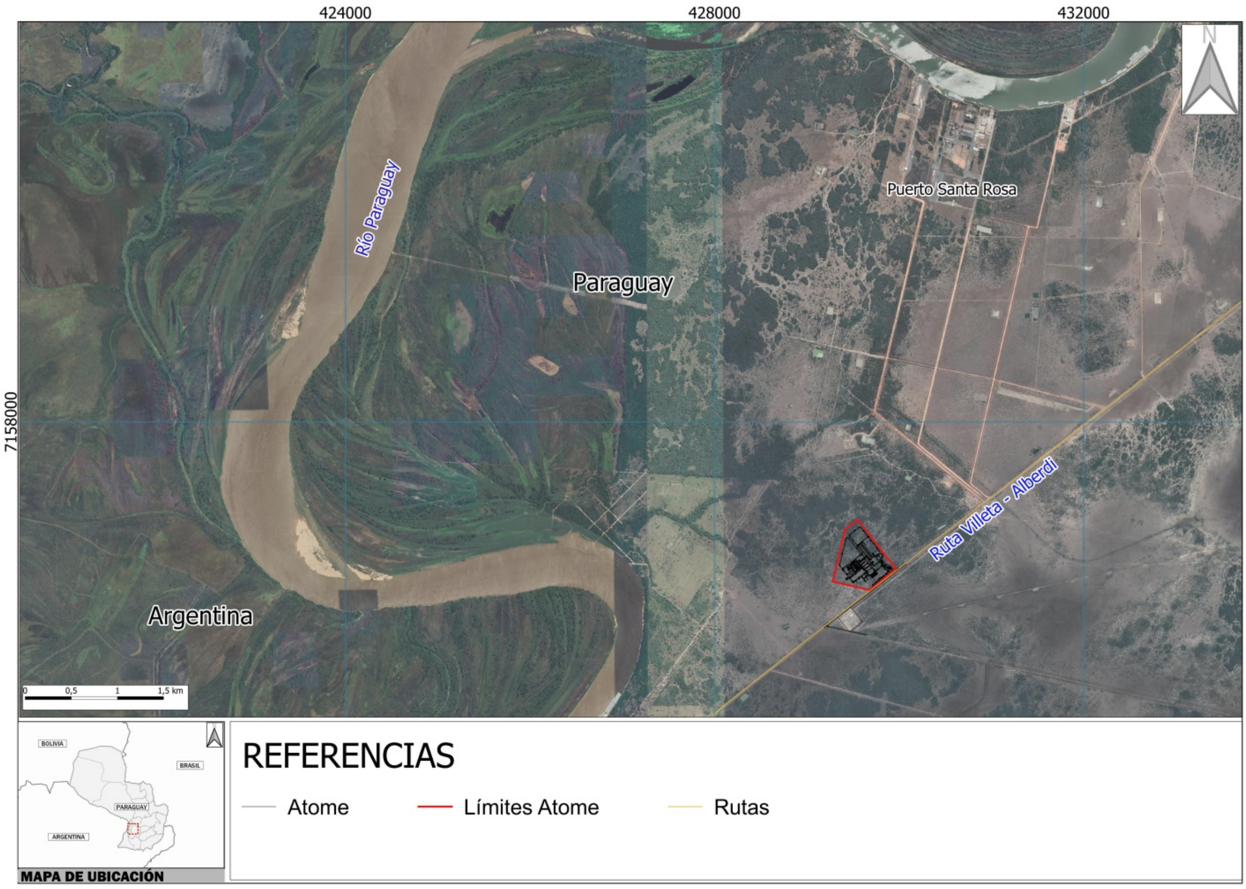
To this end, a mathematical simulation was carried out using the AERMOD model of the dispersion of pollutants (CO, NO2, PM10, PM2.5 and NH3) emitted by the main emission sources of the project and compared against the objective quality values included in national legislation, in Argentine legislation to analyse transboundary impacts and in international guidelines. Sources operating under regime conditions, always under normal operating conditions, were considered. Contingency situations were not studied.

It should be noted that no source operating in the regime will emit an appreciable amount of sulphur oxides, so this parameter was not modelled or considered in the evaluation.

ATOME described and characterised the emitting sources and the current air quality situation (baseline).

In Figure 1-1 the location of the industrial plant and the environment around it are visible.

Figure 1-1 Location of the industrial plant on satellite image



Source: Authors' creation

2. Regulations and Reference Guides

Resolution No. 259/15 of Paraguay was considered a reference regulation for pollutants, establishing the permissible air quality parameters (Table 2-1).

In addition, and to assess potential transboundary impacts, Law No. 1356/04 of the Autonomous City of Buenos Aires (Table 2-2). It should be noted that this law is used as a reference since there is no other regulation at the province of Formosa or at the national level in Argentina that establishes target air quality values.

Table 2-1 Resolution No. 259/15 Permissible air quality parameters - Paraguay

Parameter	Period	Limit (µg/m3)
CO	8 a.m.	10.000
NO2	1 h	200
	Annual	40
SO2	24 h	20
PM2.5	24 h	30
	Annual	15
PM10	24 h	150

Source: Resolution No. 259/15 – Paraguay

Table 2-2 Law 1356/04 Ambient Air Quality Standards - Buenos Aires

Parameter	Period	Limit (µg/m3)
CO	1h	40.000
	8 a.m.	10.000
$PM2._5$	24 h	65
	Annual	15
PM10	24 h	150
	Annual	50
SO2	3 h	1.300
	24 h	365
	Annual	80
NO2	Annual	100

Source: Law 1356/04 – Buenos Aires, Argentina

Also considered were the International Finance Corporation's (IFC) General Guidelines on Environment, Health and Safety, which state that projects with significant sources of air emissions that may cause substantial impacts on ambient air quality must prevent or minimise these emissions, ensuring that concentrations are not higher than those established in the current version of the World Health Organization (WHO) Air Quality Guidelines presented at Table 2-3. It sets out guiding values, objectives and progressive intermediate targets.

Table 2-3 IFC Ambient Air Quality Guidelines (WHO 2021)

Pollutant	Average Period	Level of air quality guidelines in µg/m3
NO2	1 year	40 (intermediate goal 1) 30 (intermediate goal 2) 20 (intermediate goal 3) 10 (guide)
	24 hours1	120 (intermediate goal 1) 50 (intermediate goal 2) 25 (guide)
	1 hour	200 (guide)
PM10	1 year	70 (intermediate goal 1) 50 (intermediate goal 2) 30 (intermediate goal 3) 20 (intermediate goal 4) 15 (guide)
	24 hours1	150 (intermediate goal 1) 100 (intermediate goal 2) 75 (intermediate target 3) 50 (intermediate goal 4) 45 (guide)
PM2.5	1 year	35 (intermediate goal 1) 25 (intermediate goal 2) 15 (intermediate goal 3) 10 (intermediate goal 4) 5 (guide)
	24 hours1	75 (intermediate goal 1) 50 (intermediate goal 2) 37.5 (intermediate target 3) 25 (intermediate goal 4) 15 (guide)
CO	24 hours1	7,000 (intermediate goal 1) 4,000 (guide)
	8 hours	10.000

Pollutant	Average Period	Level of air quality guidelines in µg/m3
	1 hour	35.000
	15 min	100.000
SO2	24 hours1	125 (intermediate goal 1) 50 (intermediate goal 2) 40 (guide)
	10 min	500

[1] 99th percentile (i.e. 3-4 days of exceedances per year).

Source: IFC Guidelines (WHO 2021)

To analyse air quality in terms of the presence of NH3, the Alberta *Ambient Air Quality Objectives and Guidelines Summary (*2019) was used as a reference, which sets an hourly concentration value of 1,400 µg/m3 (2 ppm) as the target quality value.

3. Calculation methodology and modelling

3.1. Description of the calculation model

AERMOD[1] is an atmospheric pollutant dispersion model recommended by the U.S. Environmental Protection Agency (EPA) for the evaluation of dispersion of pollutants from various sources. It is an emissions modelling system that simulates essential physical atmospheric processes and provides refined estimates of concentration and deposition over various meteorological conditions, considering that the average meteorology governs concentration and deposition at all distances in one hour.

It is a stationary Gaussian model for estimating air quality impacts in the near countryside (less than 50 km), applicable to both rural and urban areas, flat and complex terrain, and multiple types of sources (point, linear, surface, volumetric and *open pit*[2]).

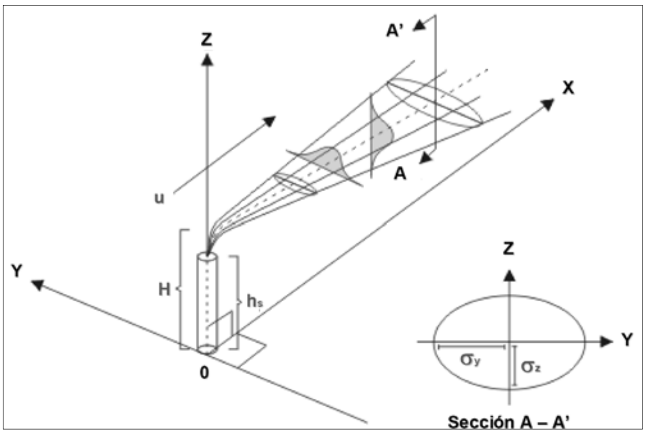
The mathematical formulation of the model uses the conservation equations of mass and transport to describe the concentration $c(x, y, z, t)$ of a given pollutant at a point (x, y, z) at time t. Assuming that the process is stationary – among other hypotheses – the following formulation is obtained:

$$c(x,y,z) = \frac{Q}{2\pi\, u\, \sigma_y\, \sigma_z} \cdot exp\left[-\frac{1}{2}\left(\frac{y^2}{{\sigma_y}^2} + \frac{(z-H_e)^2}{{\sigma_z}^2}\right)\right]$$

Where: Q is the total amount emitted, u is the wind speed, H_e is the effective height of the chimney, σ_y and σ_z are the horizontal and vertical standard deviations, respectively.

The model assumes a Gaussian concentration distribution around its symmetry axis defined by the wind's direction, as shown in Figure 3-1.

Figure 3-1 Gaussian AERMOD Model Geometry



Source: Cabrera et al (2008)

The model includes the following considerations:

[1] The AERMOD Gaussian plume dispersion model is used, with the AERMOD View software version 12.0.0 of Lakes Environmental.
[2] Sources emitted below ground level.

- It considers the effects of the turbulent wake caused by the presence of buildings, using the algorithms included in the Plume *Rise Model Enhancements* (hereinafter PRIME).
- The stable boundary layer assumes that the concentration distribution is Gaussian for both the x axis and the y axes. In contrast, the horizontal distribution is also assumed to be Gaussian in the convective boundary layer, but a biGaussian probability density function describes the vertical distribution.
- It incorporates, through a simple approach, basic concepts about the flow and dispersion of pollutants in complex terrains, where the plume is modelled both where it impacts the terrain and accompanying its altimetry variations.

The AERMOD model consists of two modular subprograms: the AERMOD *mapping program* (hereinafter AERMAP) and the AERMOD *meteorological pre-processor* (hereinafter AERMET).

AERMAP is a survey pre-processor that uses terrain data to calculate a representative ground influence height and create receiver grids.

AERMET is a meteorological pre-processor that processes the boundary layer and other parameters necessary for the operation of AERMOD.

3.2. Characterisation of emission sources under normal operation

The following point sources of emission operating under normal conditions were considered.

- Main NH3 flare
- Nitric acid abatement
- Secondary NH3 flare
- Granulation scrubber
- Milling discharge

Table 3-1 presents the description of the sources that operate under normal conditions continuously (in regime) and the characterisation of the emissions of each of them.

It should be noted that no source operating in the regime will emit an appreciable amount of sulphur oxides, so this parameter was not modelled or considered when evaluating air quality during operation (in regime). On the other hand, concerning the emission of particulate matter, for those sources in which the fraction of the emission of particulate matter corresponding to PM10 and PM2.5 is unknown, it was assumed that the total emission corresponds to the modelled pollutant (conservative premise).

Table 3-1 Characterisation of emission sources with continuous operation (in mode) – normal operation

		Main NH3 flare	Nitric acid abatement	Secondary NH3 flare	Granulation scrubber	Milling discharge
Characteristics of the issuer	Chimney outlet height above ground level (m)	16	59,2	16	72	15
	Inner diameter (m)	0,61	0,95	0,61	3,3	0,8
Emission characteristics	Emission Flux (Nm3/h)	98	58.212	98	220.000	17.000
	Outlet Temperature (°K)	1.173	433	1.173	323	358
Emission rates (g/s)	Particulate matter (PM10 and PM2.5)	-	-	-	3,06	PM10: 0.175 PM2.5:
	Nitrogen oxides (NO2)	0,0028	0,33	0,0028	-	-
	Carbon Monoxide (CO)	0,0153	-	0,0153	-	-
	Ammonia (NH3)	-	0,061	-	3,06	-

Source: Atome

The coordinates of the location of all the sources considered are presented in Table 3-2.

Table 3-2 Location and Operating Condition of Emitting Sources – Normal Operation

Fountain	UTM Coordinates (21H)		Normal Operation
	East (m)	South (m)	
Main NH3 flare	429.357	7.156.343	Continuous
Nitric acid abatement	429.531	7.156.432	Continuous
Secondary NH3 flare	429.510	7.156.489	Continuous
Granulation scrubber	429.600	7.156.543	Continuous
Milling discharge	429.570	7.156.483	Continuous

Source: Atome

3.3. Characterisation of local meteorology

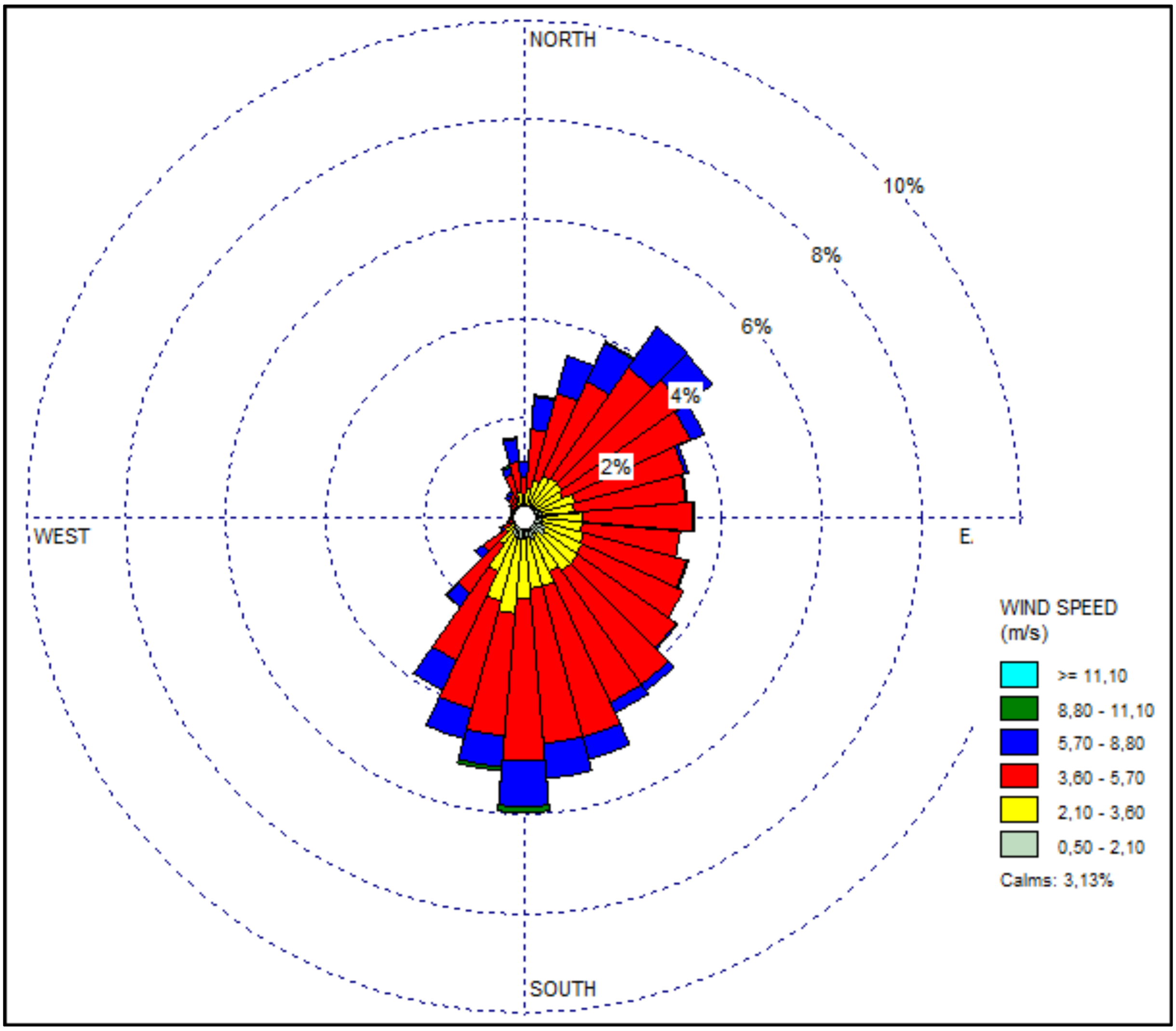
The AERMET pre-processor uses meteorological measurements representative of the modelling domain to estimate boundary layer parameters. The depth and the dispersion of the pollutants are influenced at the local scale by the surface characteristics of the area under study: roughness, albedo and Bowen radius. These surface variables, together with the basic meteorological observations (wind speed and direction, temperature, and cloud cover), are required by AERMET to calculate the parameters of the planetary boundary layer (friction velocity, Monin-Obukhov length, convective velocity scale, temperature scale and surface heat flux). The stability of the planetary boundary layer is obtained through the analysis of surface heat flux.

The site under study does not have a weather station that records site-specific parameters. Therefore, the necessary meteorological data were obtained using the *Weather Research and Forecasting* (WRF) forecasting model, which uses information provided by the *National Centres for Environmental Prediction Global Reanalysis*. The WRF model is a state-of-the-art mesoscale numerical weather prediction system for atmospheric research and operational forecasting. It serves various meteorological applications at scales ranging from tens of meters to thousands of kilometres.

The meteorological characterisation used for this study was provided by ATOME and had the complete series of hourly values of the surface meteorological variables and higher borehole values (two per day) for the period from 2020 to 2022 in the project's location in Villeta, Paraguay.

The 2020–2022 compass rose in Figure 3–2 shows the main wind directions over the three years analysed. The predominant directions are located from the S direction to the N direction. The average wind speed is approximately 3.75 m/s, with 3.13% of calm winds recorded (< 0.5 m/s).

Figure 3-2 Compass rose (blowing from)



Note: The period considered is January 2020 - December 2022. Average speed: 3.75 m/s.
Source: ATOME

3.4. Characterisation of the land and main buildings within the industrial site

For the construction of the physical model, the general *layout* of the ATOME industrial plant was used (according to the plan "*VILLETA PLANT LAYOUT r05C*"), assigning names and heights to all the buildings, structures, and tanks.

The topographic survey carried out by the *Shuttle* Radar (SRTM)'s topographic mission (operated by NASA) was used for the terrain characterisation. This mission generated a high-resolution global topographic survey in February 2000. In the project area, the resolution of the study corresponds to a grid of approximately 90 m on each side.

3.5. Concentration conversion in integration periods of less than 1 hour

The calculation methodology of the AERMOD software includes hourly steps of 1-hour duration, so estimating the resulting concentration in shorter integration periods must be done using a conversion of the hourly concentration obtained.

Concentration in periods of less than 1 hour was estimated following the Ontario *Air Dispersion Modelling Guide*[3] recommendation as follows:

$$C_0 = C_1 \left(\frac{t_1}{t_0}\right)^n$$

Where:

$$t_1 \text{: } Longer\ average\ time \quad t_0 \text{: } Shorter\ average\ time \quad n \text{: } Stability\ exponent$$

As a conservative approach, n was considered equal to 3: n=0.28.

[3] Ontario. Ministry of the Environment. (2016). *Air Dispersion Modelling Guideline for Ontario: Guidance for Demonstrating Compliance with the Air Dispersion Modelling Requirements Set Out in Ontario Regulation 419/05, Air Pollution-Local Air Quality Made Under the Environmental Protection Act. Version 3.0*. Ministry of the Environment.

4. Baseline Characterisation

The baseline characterisation was provided by ATOME and is presented in Annex I[4]. The parameters surveyed were PTS, PM10, PM2.5, SO2, CO, CO2, O3 and NO2.

In Table 4-1 the main information obtained from the baseline characterisation report is presented, where the maximum concentration measured in periods of 10 minutes duration and periods of 24 h can be seen for all the parameters surveyed, and in periods of 1 h and 8 h for some.

In addition, Table 4-1 compares the measured air quality (baseline) with the standards and reference guide values considered. Green indicates the parameters that meet the target quality values.

For the interpretation of the information contained in the characterisation of the baseline (Annex I), hypotheses were made for the evaluation of those parameters whose objective quality values are expressed in integration periods that were not reported (15 minutes and 1 h of CO, and 3 h of SO2). In these cases, it was considered, as a conservative scenario, that the concentration in the unreported reference period can be assumed to be equivalent to the maximum concentration of 10 minutes surveyed for the comparison sought. In Table 4-1 The cases where such a hypothesis was made are indicated. The annual period was not analysed because the number of days surveyed is insufficient to estimate annual values under reasonable hypotheses.

[4] CSI Ingenieros did not perform a verification or validation analysis of the local air quality characterization (baseline) provided by ATOME.

Table 4-1 Baseline air quality representative values and comparison with standards and reference guides

Parameter	Period	Baseline Concentration (µg/m3)	Paraguay Resolution No. 259/15 (µg/m3)	Buenos Aires Law No. 1356/04 (µg/m3)	IFC Guidance (WHO 2021) (µg/m3)
CO	15 min	7682	-	-	100.000
	1 hour	7682	-	40.000	35.000
	8 hours	400	10.000	10.000	10.000
	24 hours	400	-	-	4.0001
NO2	1 hour	3,8	200	-	200
	24 hours	2,7	-	-	251
	1 year	No data	40	100	10
PM2.5	24 hours	10	30	65	151
	1 year	No data	15	15	5
PM10	24 hours	15	150	150	451
	1 year	No data	-	50	15

[1] 99th percentile (i.e. 3-4 days of exceedances per year).

[2] Maximum concentrations measured in 10 minutes

Source: Prepared by the authors based on ATOME (Annex I), Resolution No. 259/15, Law No. 1356/04 and IFC guides.

5. Results during normal operation in regime

This chapter shows the results obtained for each pollutant considered when the sources operate continuously (in regime) under normal conditions.

Table 5-1 summarises the maximum concentration values obtained for each pollutant and each integration period considered. The same table also includes the baseline characterisation (see paragraph 4), the resulting concentration foreseen in the future situation (operation project under regime + baseline), and the objective quality values provided for in the regulations and reference guides considered. The result of comparing the expected concentration in the future situation with these target quality values is indicated in colour.

The slides show the isoconcentration maps resulting from the operation of the plant under regime conditions for the periods of 1, 8 and 24 hours, as well as for the annual period. It should be noted that these Maps refer only to the expected concentration resulting from the operation of the project regime and do not include the current values (baseline). They reflect the incremental contribution expected by the project's operation under regime only and do not represent the future situation (project operation under regime + baseline).

In the case of PM10 and PM2.5 pollutants, the IFC's daily target quality value was compared using the 99th percentile, which corresponds to the 4th day with the highest concentration[5]. It should be recalled that in the PM10 and PM2.5 models carried out, the conservative hypothesis was assumed that 100% of the emission of particulate matter corresponded to each of the fractions modelled in those sources in which the particle size distribution of the emission of particulate matter emitted is not available. Although the IFC guidelines also consider the 99th percentile for the daily concentration of the CO and NO2 parameters, it was unnecessary to consider this percentile due to the low maximum daily concentration values obtained.

Concerning the results obtained for the CO parameter, as seen in Table 5-1, the incremental input the project will generate will be minimal compared to the values surveyed during the baseline characterisation. In addition, the expected concentrations in the future scenario (project Operation under regime + baseline) are significantly lower than the target quality values proposed by the regulations and reference guides.

For the NO2 parameter, both the incremental contribution of the project and the current situation (baseline) present low values in integration periods of 1 and 24 hours, so the target quality values are not expected to be exceeded in the future situation. With reasonable certainty, the annual target quality value is not likely to be exceeded (although the baseline characterisation is lacking in this integration period) because the incremental project contribution is expected to be very low. Notwithstanding the preceding, it is considered pertinent to characterise the baseline in the annual period to strengthen the conclusions reached for this integration period.

[5] The IFC guideline establishes that the maximum expected target quality value corresponds to the 99th percentile, which implies that it can be exceeded in 3 to 4 days a year (see numeral 4).

Regarding the emission of particles (PM10 and PM2.5), the incremental contribution that the project will generate operating under regime conditions is low, both for the daily period and for the annual period. The daily expected values in the future condition (project operating in regime + baseline) comply with the objective quality values established in Paraguayan and Argentine regulations and the guide value proposed by the IFC. For the annual concentration values of PM10 and PM2.5, in the absence of the characterisation of the current situation (baseline), it is not possible to predict the level of compliance with the future situation. Notwithstanding the above, it would be reasonable to assume that the annual values provided for Paraguayan regulations and reference guides will not be exceeded due to the limited incremental contribution the project is expected to generate. It is recommended that the characterisation of the current situation (baseline) be strengthened to predict the level of future compliance for both parameters on an annual basis and strengthen the conclusions reached regarding the daily concentrations expected in the future situation.

Concerning the emission of ammonia (NH_3), the project foresees a low emission during the operation (in regime). The maximum hourly concentration of immission expected is significantly lower than the guide value established by the Environmental Authority of Alberta, Canada. This value is used as a reference, so the target quality value is not expected to be exceeded, even if the current air quality regarding this parameter (baseline) is unknown.

Table 5-1 Summary of results obtained for normal operation under the regime and comparison with the reference standard

Parameter	Period	Modelling results of normal operation in regime (µg/m3)	Baseline (µg/m3)	Expected future situation: modelling + baseline (µg/m3)	Normative Values / Guidelines			Remarks
					Paraguay Resolution No. 259/15 (µg/m3)	Buenos Aires Law No. 1356/04 (µg/m3)	IFC Guidance (WHO 2021) (µg/m3)	
CO	1 h	21,2	7682	789,2	-	40.000	35.000	Compliance with target quality values
	8 a.m.	7,7	400	407,7	10.000	10.000	10.000	Compliance with target quality values
	24 h	3,1	400	403,1	-	-	4.0003	Compliance with target quality values
NO2	1 h	3,5	3,8	7,3	200	-	200	Compliance with target quality values
	24 h	0,6	2,7	3,3	-	-	253	Compliance with target quality values
	Annual	0,05	No data	Not calculated due to lack of baseline value	40	100	10	Expected Fulfillment of Annual Target Quality Value
PM10	24 h	8,1	15	23,1	150	150	-	Compliance with Target Quality Value
	24 h – 99th percentile. 4th day senior concent3	5,5		20,5	-	-	453	Compliance with target quality values
	Annual	1,1	No data	Not calculated due to lack of baseline value	-	50	15	Expected Fulfillment of Annual Target Quality Value
PM2.5	24 h	4,2	10	14,2	30	65	-	Compliance with target quality values
	24 h – 99th percentile.	3,5		13,5	-	-	153	Compliance with target quality values

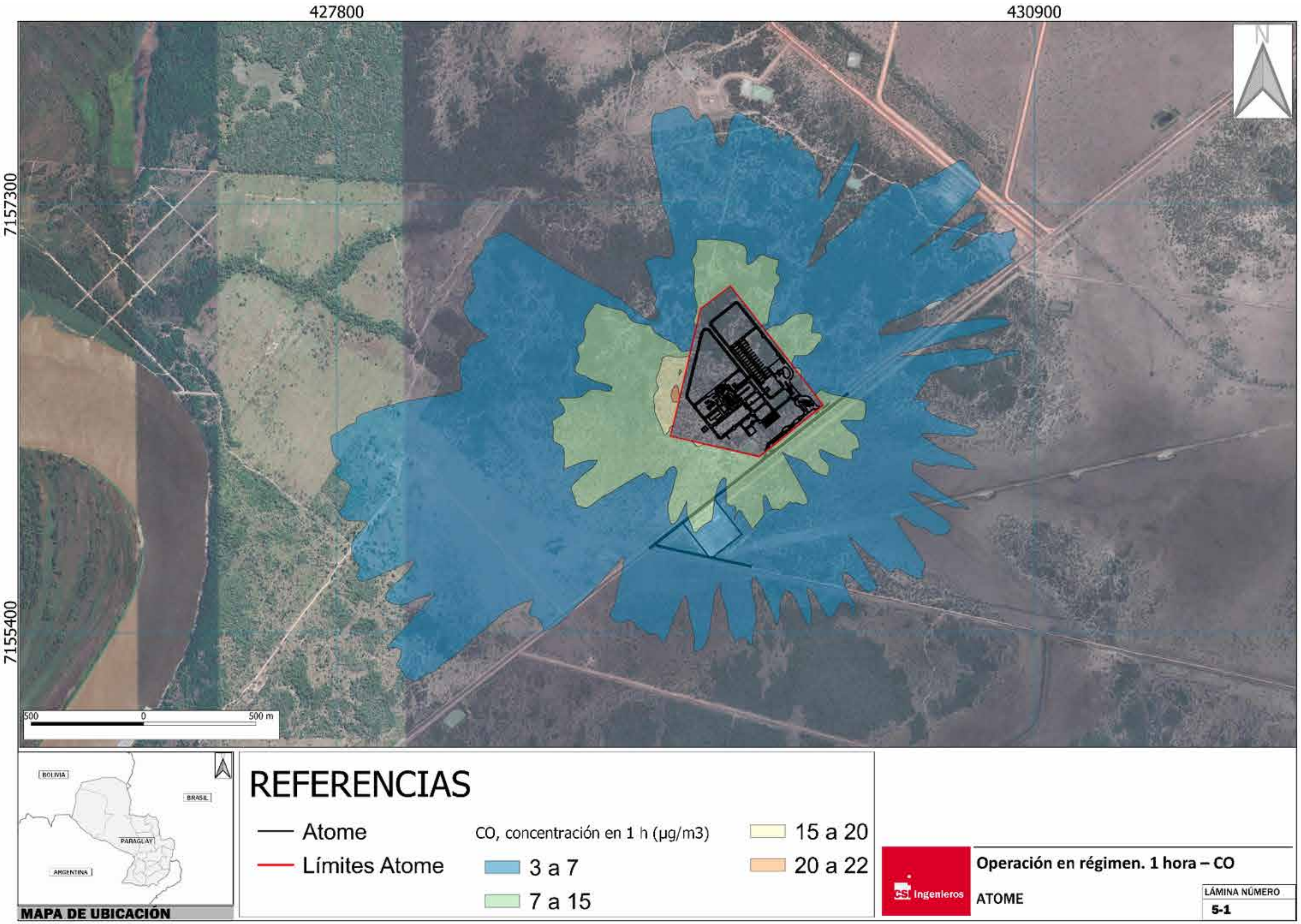
Parameter	Period	Modelling results of normal operation in regime (µg/m3)	Baseline (µg/m3)	Expected future situation: modelling + baseline (µg/m3)	Normative Values / Guidelines			Remarks
					Paraguay Resolution No. 259/15 (µg/m3)	Buenos Aires Law No. 1356/04 (µg/m3)	IFC Guidance (WHO 2021) (µg/m3)	
	4th day senior concent3							
	Annual	0,7	No data	Not calculated due to lack of baseline value	15	15	5	Expected Fulfillment of Annual Target Quality Value
NH3	1 h	11	No data	Not calculated due to lack of baseline value	-	-	-	Expected compliance with the target quality value of 1,400 µg/m3 (Value Guide Alberta, Canada)

[1] Modeling Result for Hourly Concentration

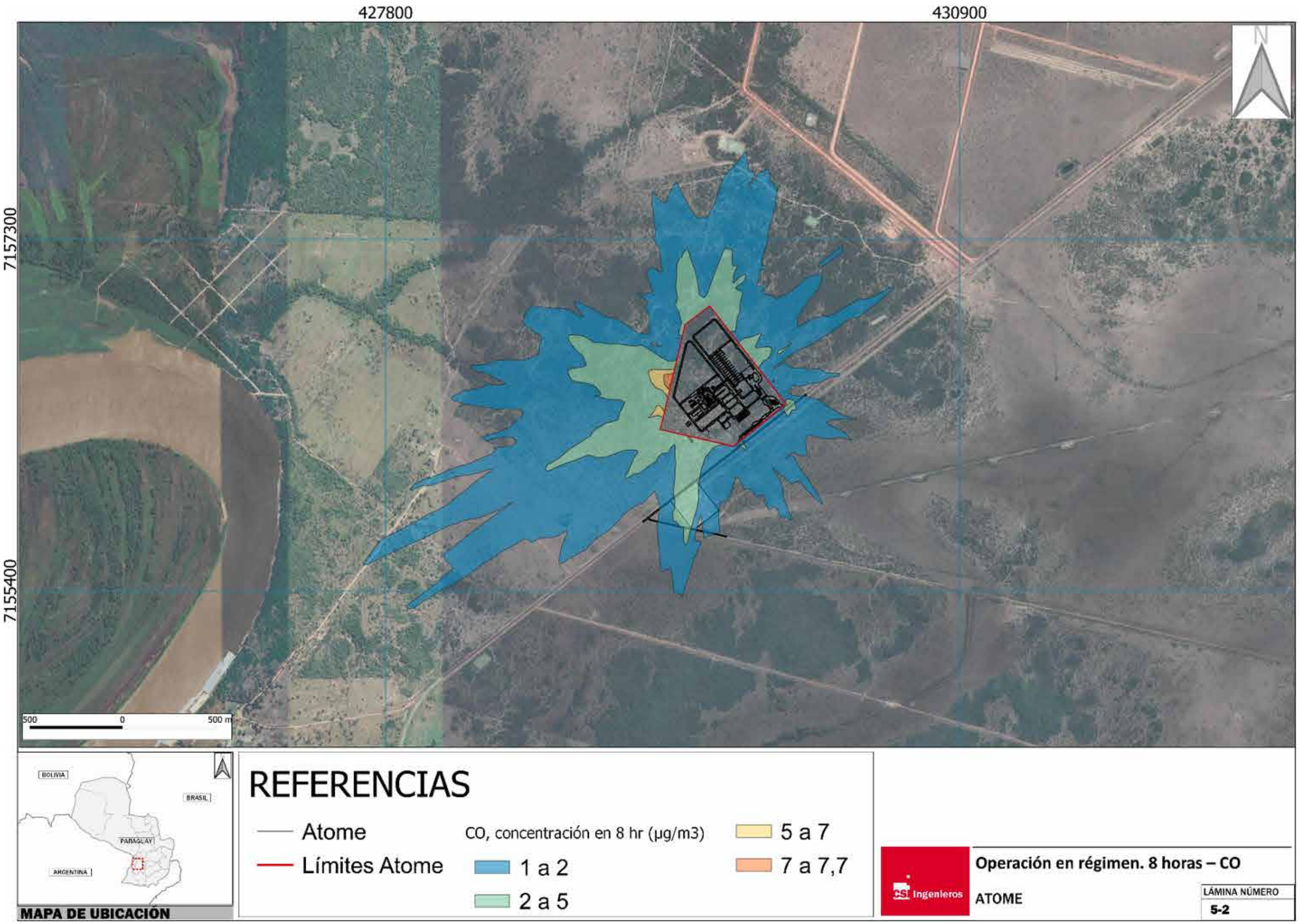
[2] Maximum concentration measured in 10 minutes

[3] 99th percentile (i.e., 3-4 days of exceedances per year).

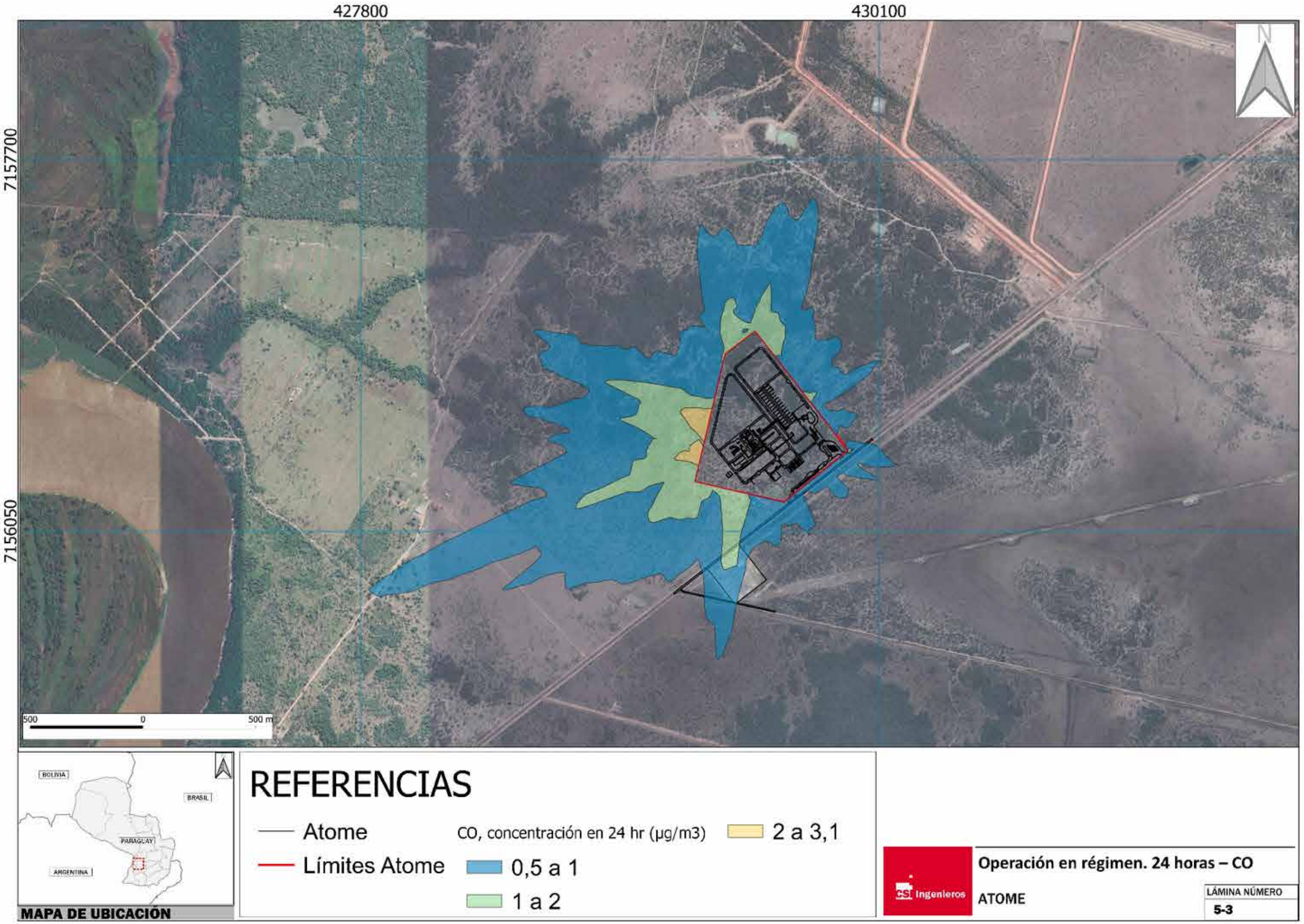
Map 5-1 Isoconcentration curves. Operation in regime. 1 hour – CO



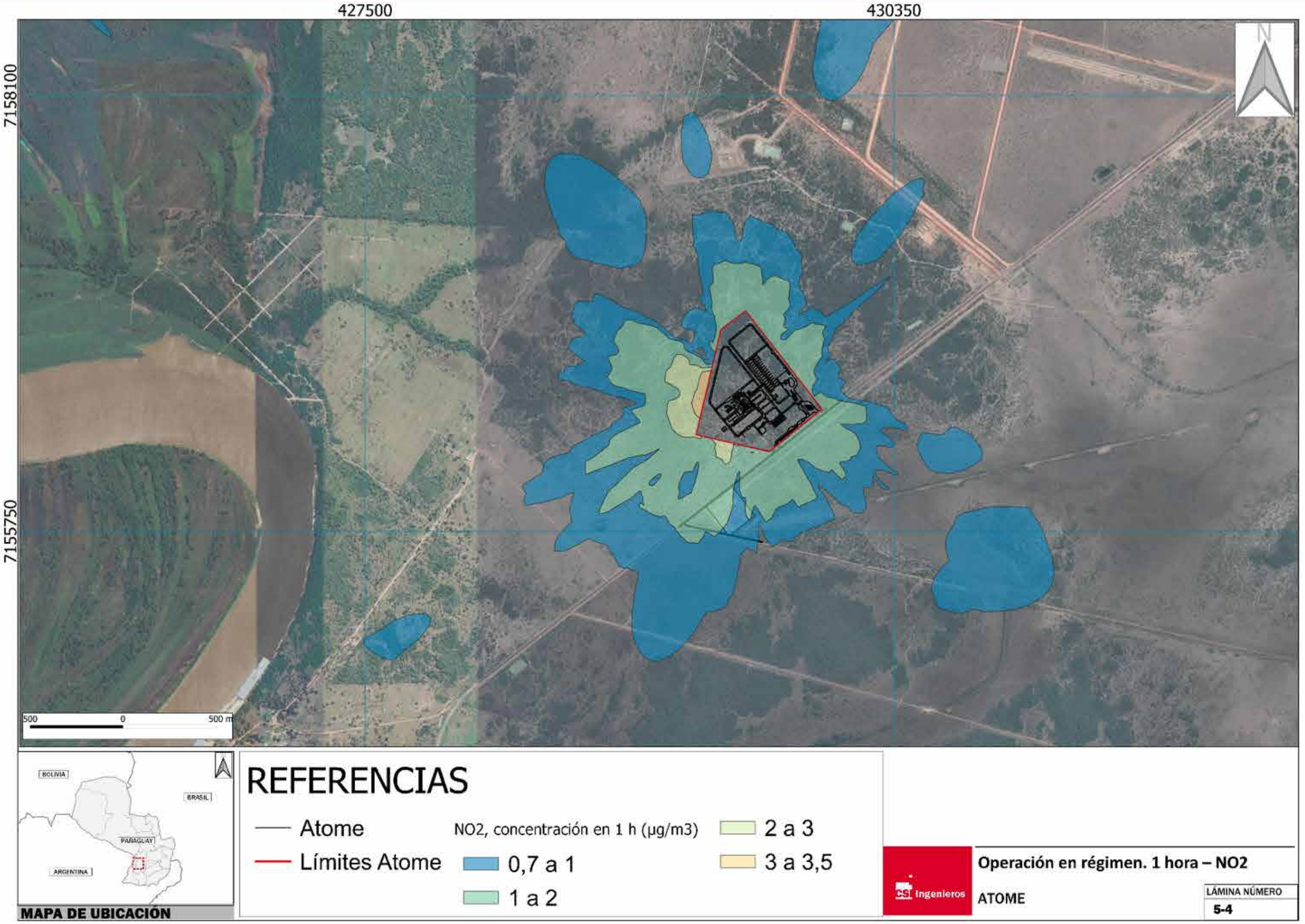
Map 5-2 Isoconcentration curves. Operation in regime. 8 hours – CO



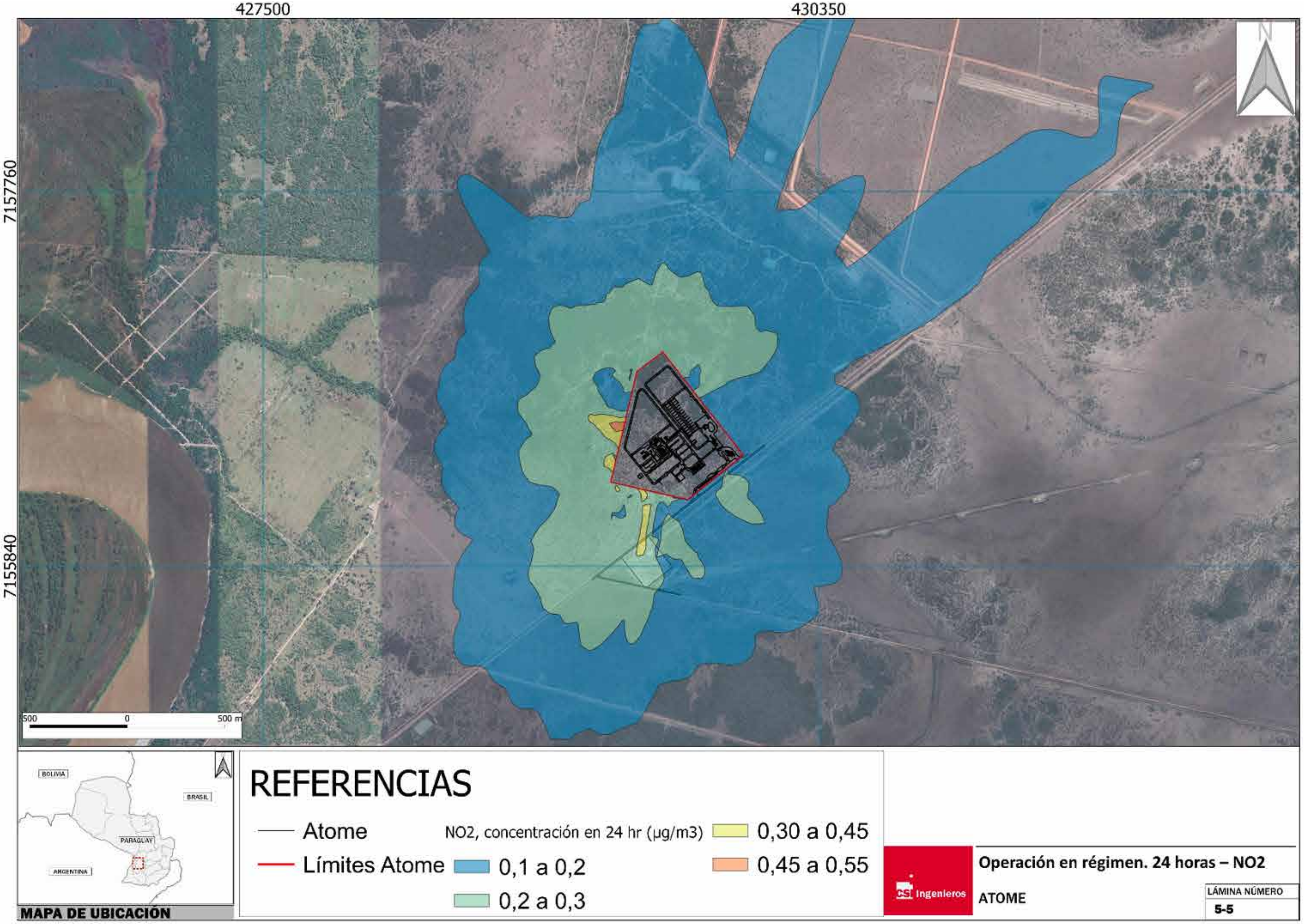
Map 5-3 Isoconcentration curves. Operation in regime. 24 Hours – CO



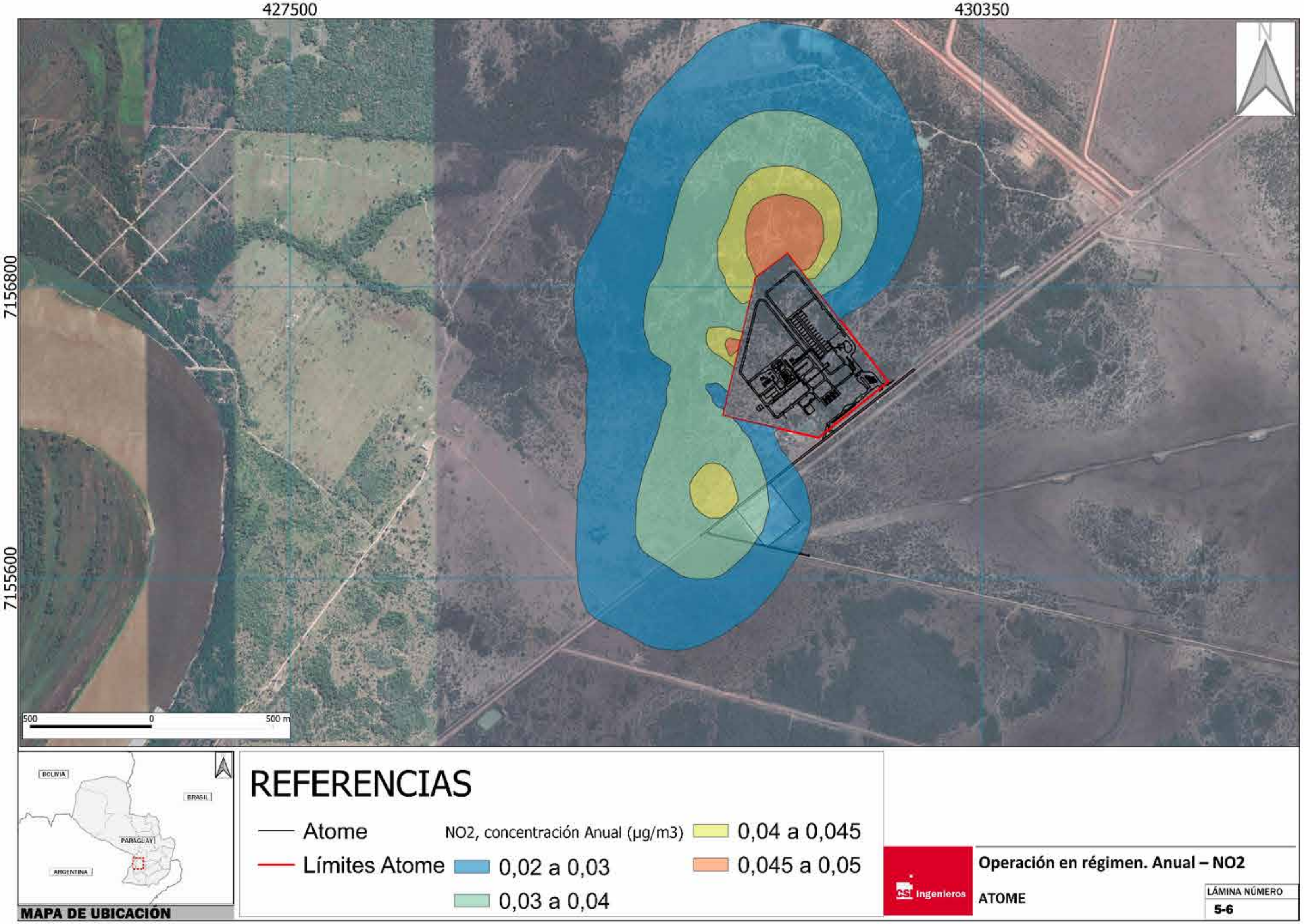
Map 5-4 Isoconcentration curves. Operation in regime. 1 hour – NO_2



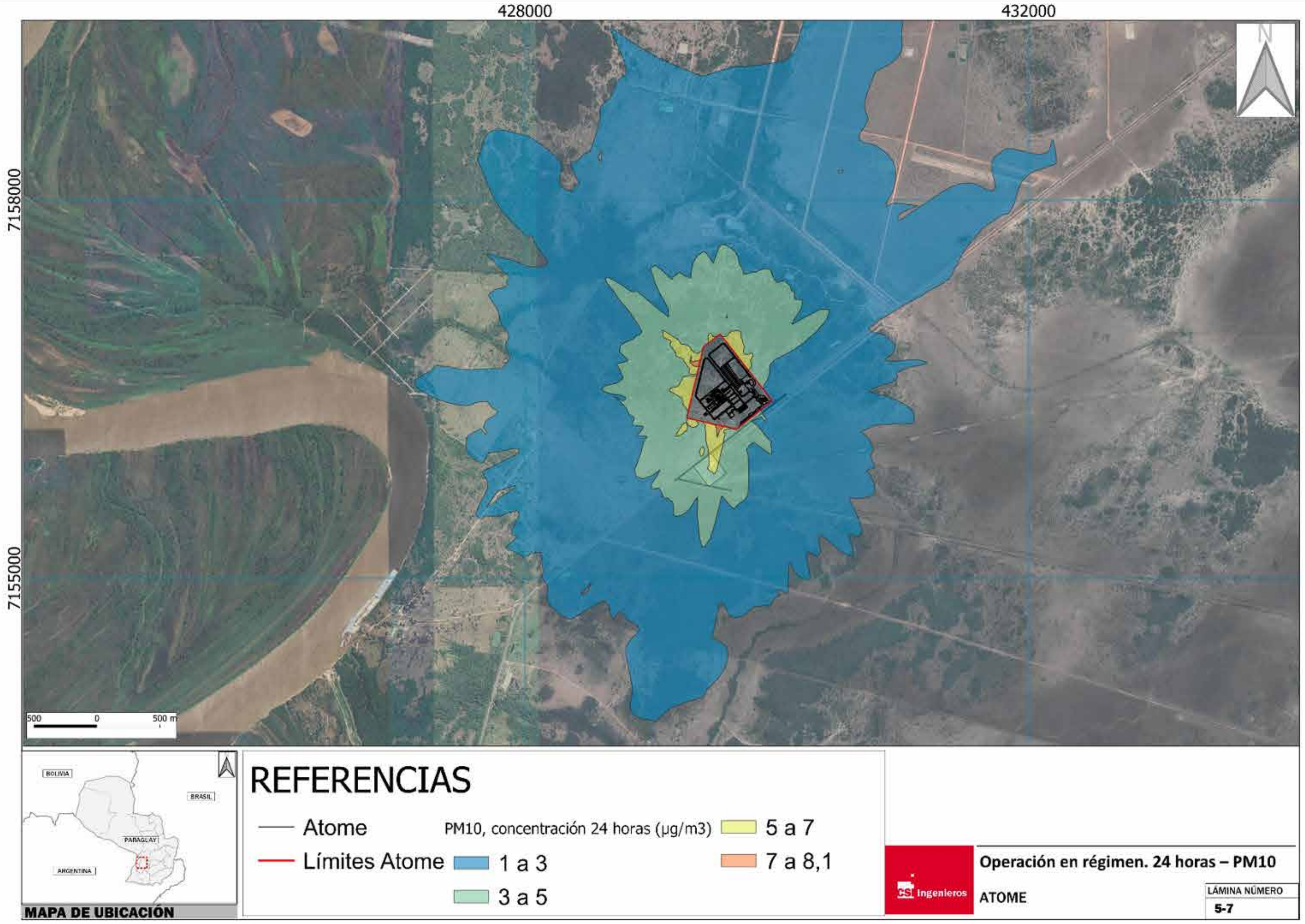
Map 5-5 Isoconcentration curves. Operation in regime. 24 hours – NO_2



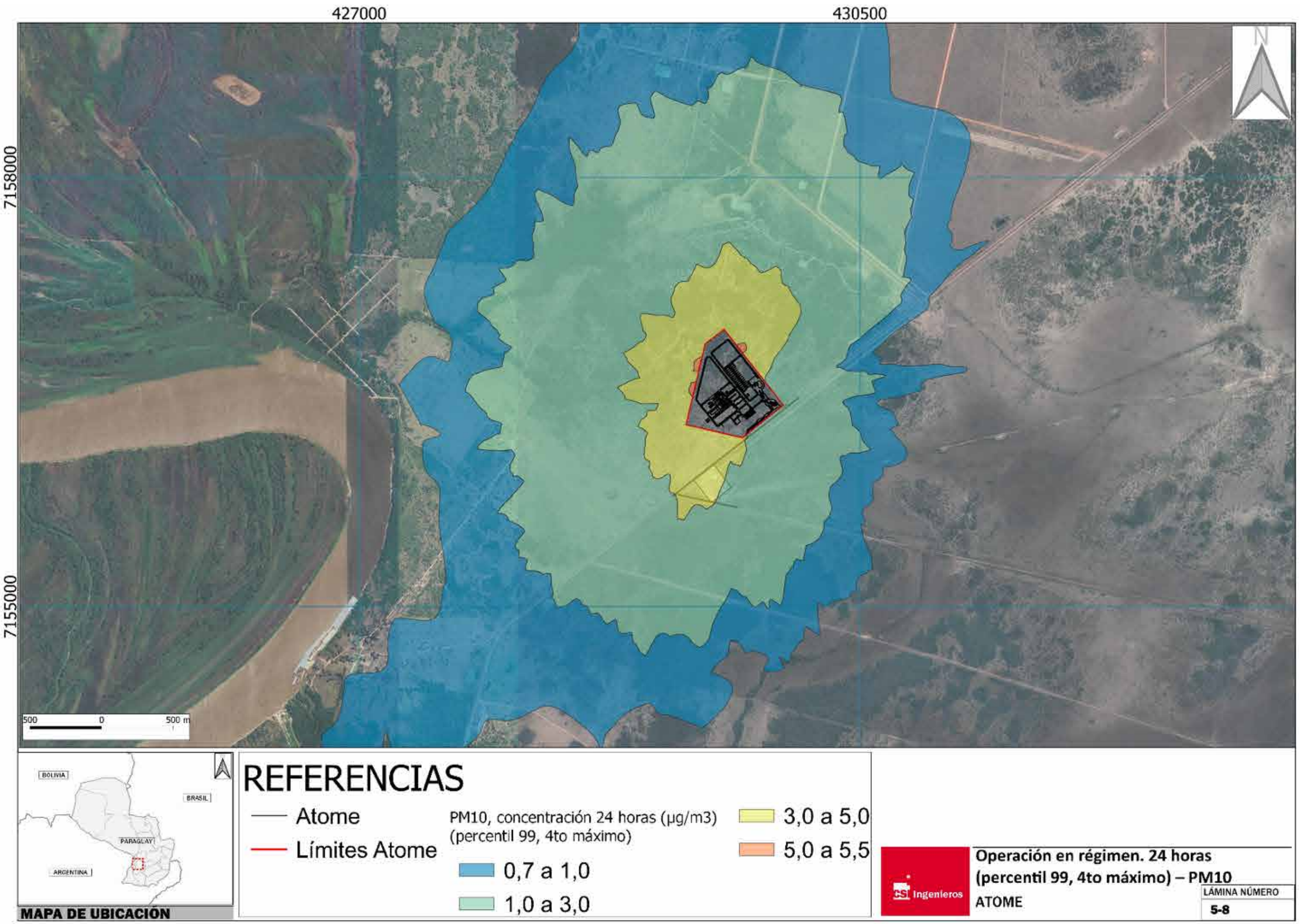
Map 5-6 Isoconcentration curves. Operation in regime. Yearly – NO_2



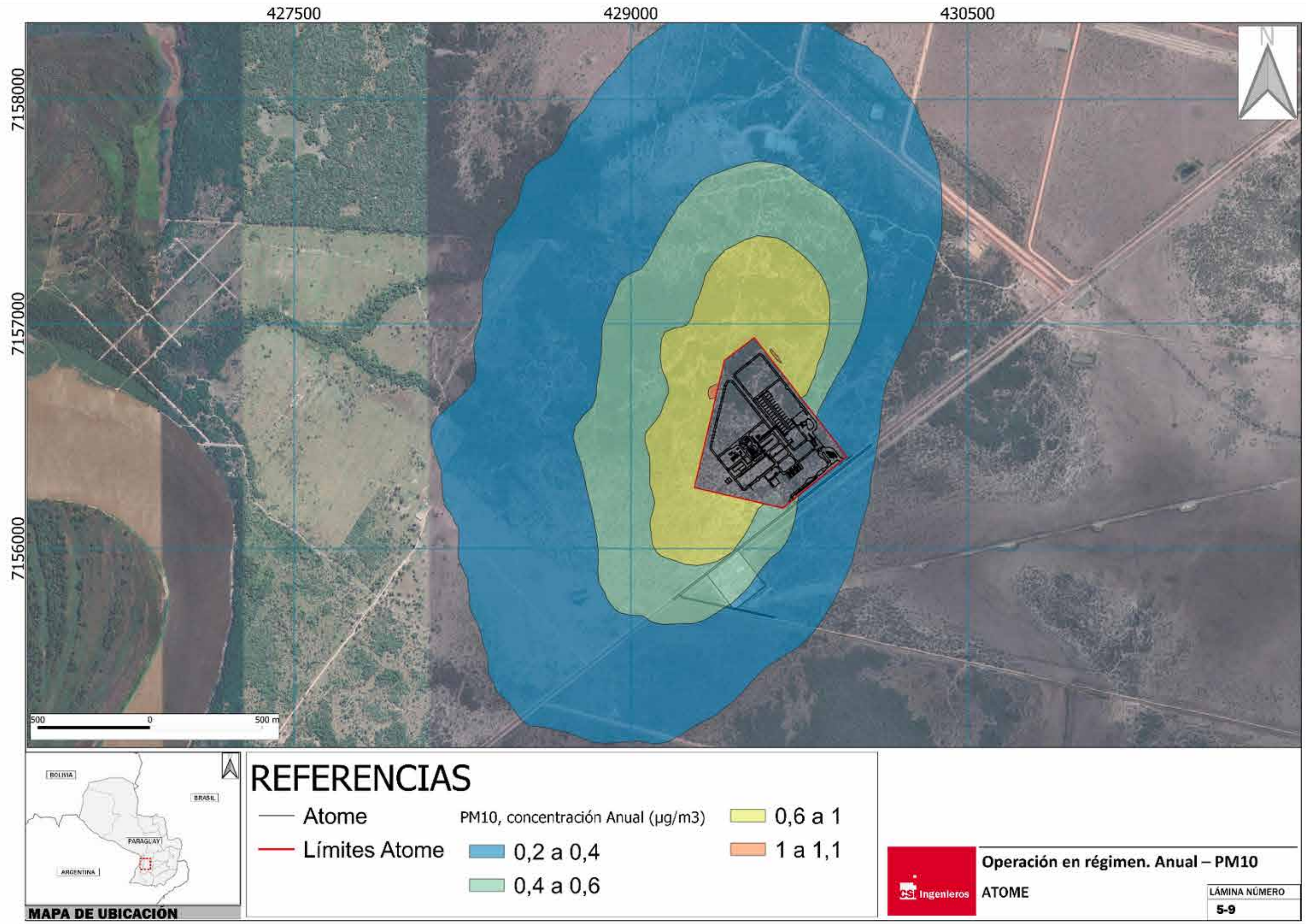
Map 5-7 Isoconcentration curves. Operation in regime. 24 hours – PM_{10}



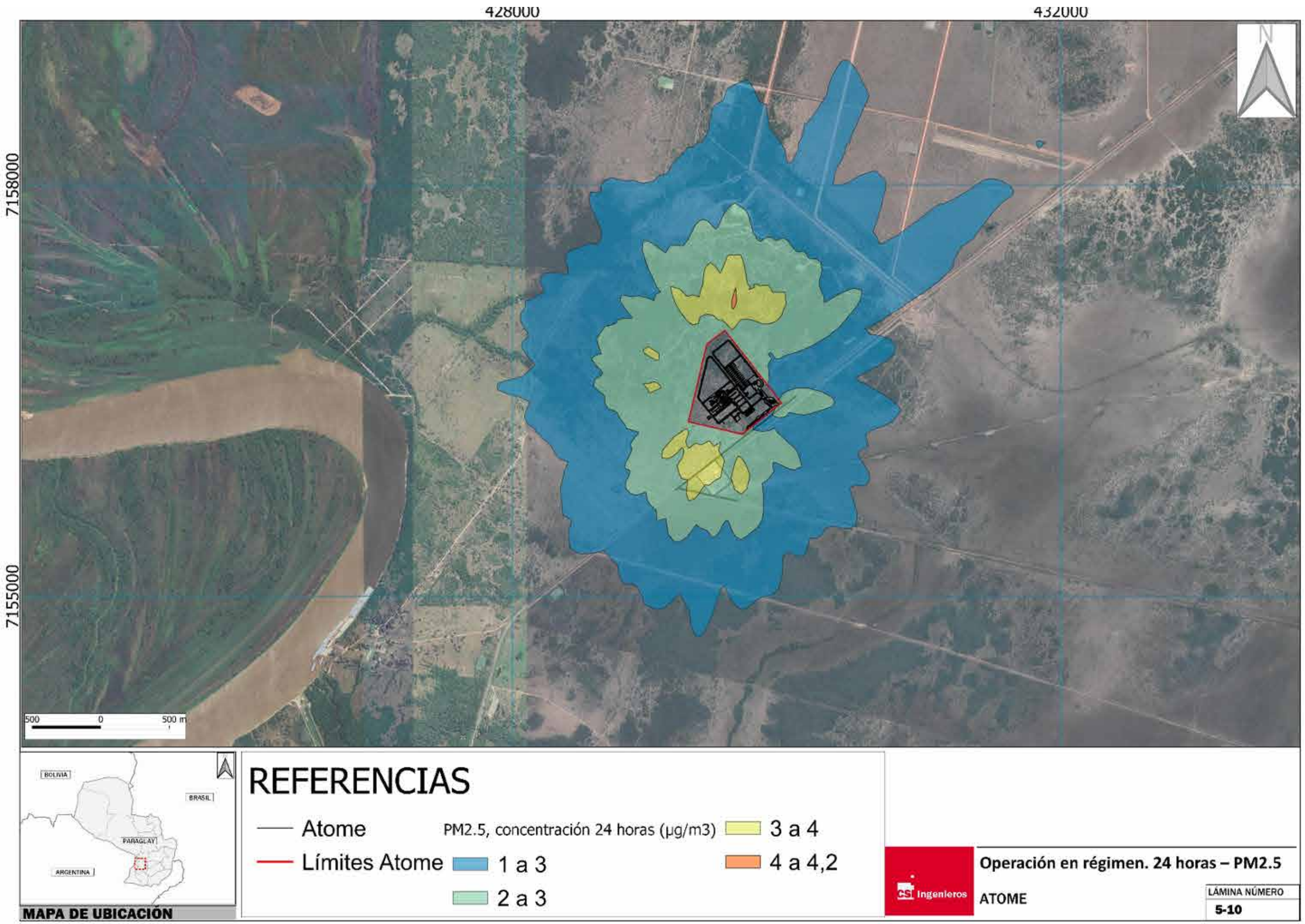
Map 5-8 Isoconcentration curves. Operation in regime. 24 hours (99th percentile, 4To maximum) – PM10



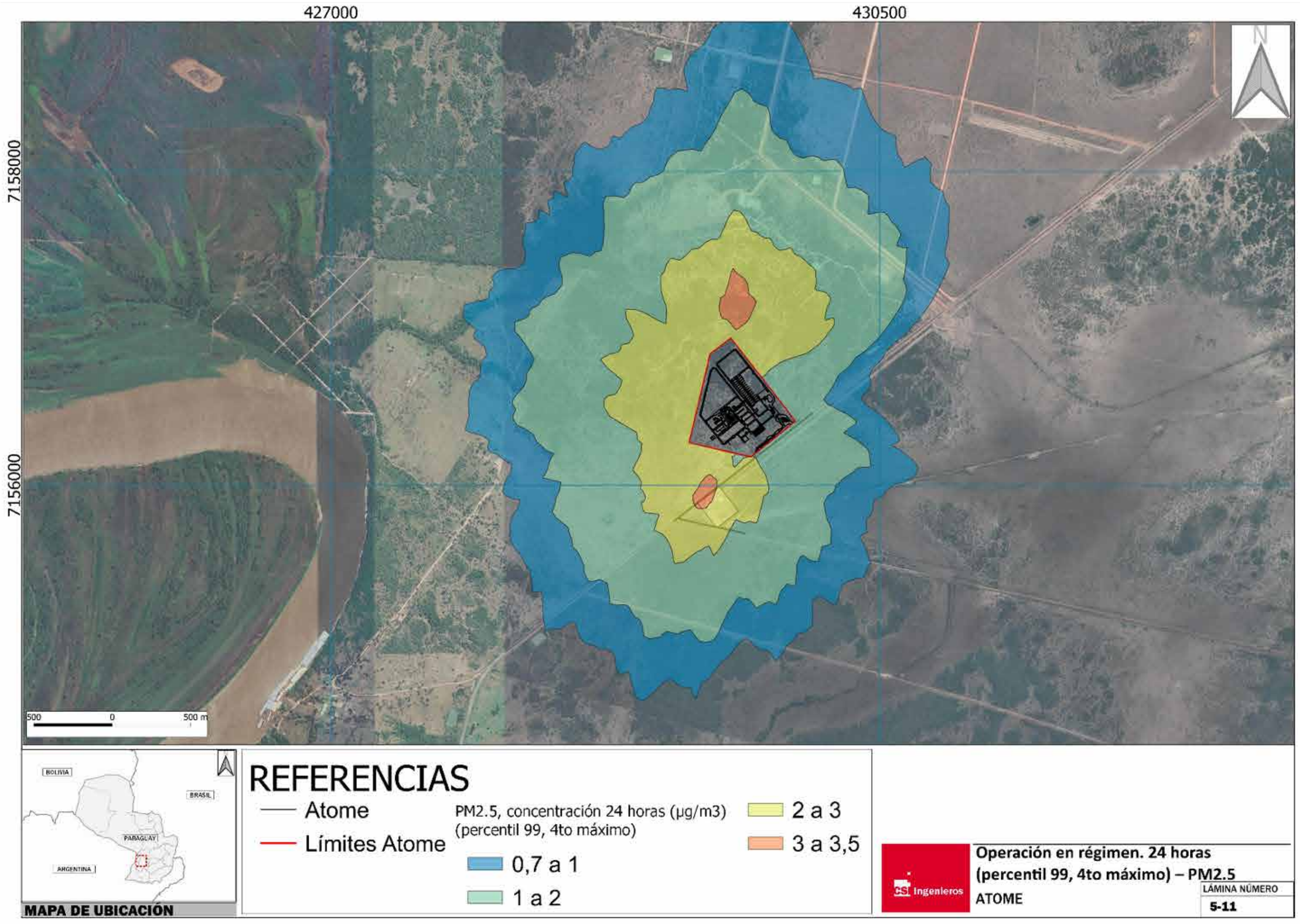
Map 5-9 Isoconcentration curves. Operation in regime. Annual – PM_{10}



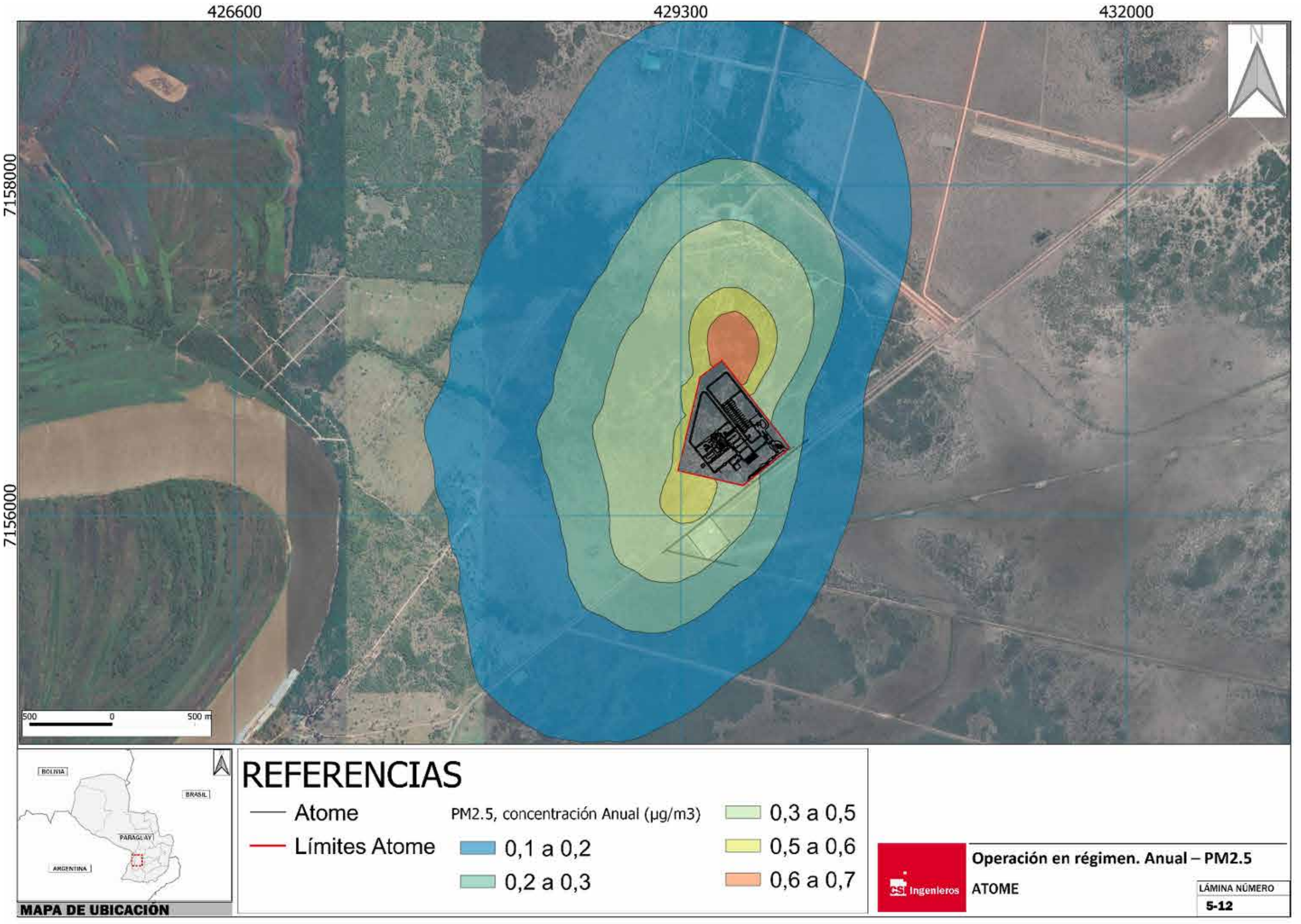
Map 5-10 Isoconcentration curves. Operation in regime. 24 hours – $PM_{2.5}$



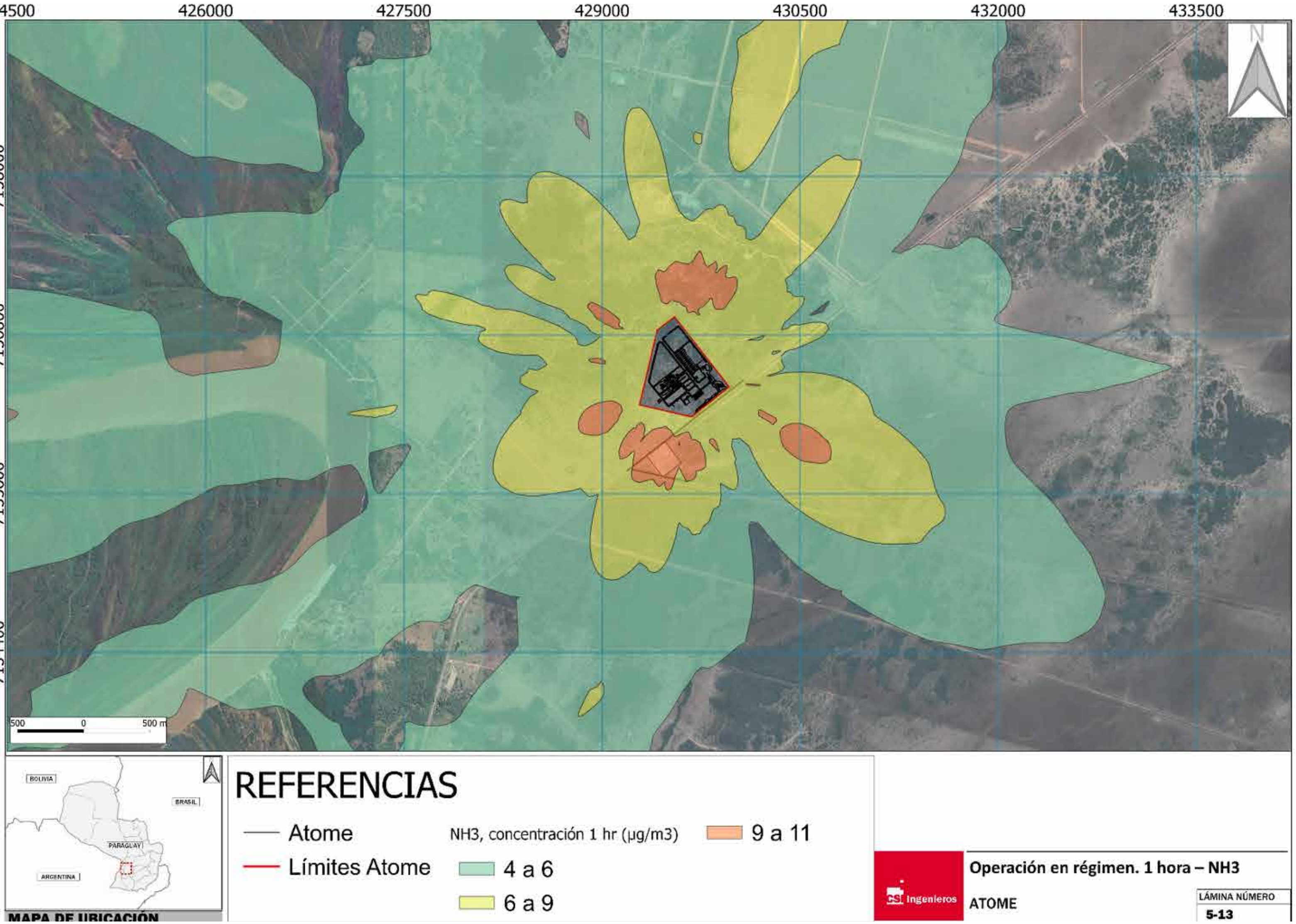
Map 5-11 Isoconcentration curves. Operation in regime. 24 hours (99th percentile, 4To maximum) – PM2.5



Map 5-12 Isoconcentration curves. Operation in regime. Annual – $PM_{2.5}$



Map 5-13 Isoconcentration curves. Operation in regime. 1 hour – NH_3



6. Conclusions

An evaluation was carried out of the potential impact on air quality resulting from the operation of the ATOME green hydrogen, ammonia, and fertiliser production plant under normal operating conditions. Compliance with the objective quality values included in national legislation, Argentine legislation to analyse transboundary impacts, and international guidelines were examined. A mathematical simulation of the dispersion of pollutants CO, NO2, PM10, PM2.5 and NH3 was carried out using the AERMOD model, and ATOME provided the characterisation of the baseline. It included the survey of the parameters PTS, PM10, PM2.5, SO2, CO, CO2, O3 and NO2.

The results obtained during normal operation in regime (continuous operation) foresee that the future air quality (project in regime + baseline) will comply with all the objective quality values stipulated in the national, Argentine, and IFC guidelines for all parameters and all short-term integration periods considered. Although the baseline characterisation for annual periods is lacking, it is expected with reasonable certainty that the annual target quality values will not be exceeded. However, the characterisation of the current situation (baseline) is recommended to be strengthened mainly for the annual period to reinforce the conclusions reached.

About the NH3 parameter, the target quality value considered is not expected to be exceeded (Ontario, Canadian regulations).

ANNEX I
BASELINE RESULTS

<table>
<tr><td rowspan="2">Aër Gestão Ambiental</td><td colspan="3">ENVIRONMENTAL DIAGNOSIS AIR QUALITY MONITORING</td><td rowspan="2">acoem Creating environments of possibility</td></tr>
<tr><td colspan="3">ATOME PROJECT - PARAGUAY
JGP CONSULTANCY
JUNE / 2023</td></tr>
<tr><td rowspan="2">INTERNAL NO.</td><td rowspan="2">REVIEW</td><td rowspan="2">PAGE</td><td colspan="2">TYPE OF AUDITS:</td></tr>
<tr><td>A- Data processing</td><td>B - Elaboration</td></tr>
<tr><td rowspan="2">AER-RTAMB-001/23</td><td rowspan="2">00</td><td rowspan="2">1/1</td><td>C - Revision/Formatting</td><td>D - Meteorology</td></tr>
<tr><td>E - Approval</td><td>F - Validation</td></tr>
</table>

REVIEW	TYPE OF AUDIT	DESCRIPTION	BY	DATE
00	**A**	Data processing	Jurandir R. Brito	03/06/2023
00	**B**	Elaboration	Jurandir R. Brito	04/06/2023
00	**C**	Proofreading / Formatting	Jurandir R. Brito	05/06/2023
00	**D**	Meteorology	Silvio de Oliveira	05/06/2023
00	**E**	Approval	Jurandir R. Brito	05/06/2023
00	**F**	Validation	Nicolas Isnard	05/06/2023

This document can only be amended by AËR Consultancy

Environmental Diagnosis / Physical Environment Air Quality Monitoring PROJECT ATOME / PARAGUAY

June 2023

Summary

***1 - Parameter legislated in Paraguay - Resolution Nº259/15**

1. SYNOPSIS

The synopsis presents a diagnosis of the meteorological conditions and air quality in the area where ATOME's Green Hydrogen production unit will be located.

In addition, the aim is to explain the complex interrelationship between emissions, the behaviour of atmospheric variables and the possible effects of the synergy of these factors on the air quality of the area assessed.

Meteorology and Air Pollutant Dispersion

Meteorological conditions affect a given location and result in various processes that act on different scales, influenced by atmospheric variables, which interact directly with the circulation, transport and dilution of pollutants in the atmosphere. The key variables for environmental monitoring are wind direction and speed, as well as topography and the presence of bodies of water.

During the monitoring period, the predominant winds were between the East-Northeast (ENE) and East-Southeast (ESE) quadrants, with the greatest predominance in the East (E) and East-Northeast (ENE) directions, between 25 and 30% in each direction, which together totalled approximately 60% of the predominant wind. The average wind speed was 0.51m/s, with the highest wind speed, 4.49m/s, occurring on 22 May 2023. The average temperature was 20.30ºC and the maximum was 31.27ºC, the average humidity was 81.25% and the average pressure was 758mmHg.

The air quality index remained at **"Good"** quality throughout the monitoring period. The environmental levels of the atmospheric pollutants monitored, in accordance with the air quality standards established by Resolution Nº259/2015 of the Paraguay Environment Secretariat and the WHO 2021 Global Air Quality Guidelines, were always below the standards.

This corroborates the fundamental aspect of this report: identifying background concentrations in the area of the future Green Hydrogen plant.

***1 - Parameter legislated in Paraguay - Resolution Nº259/15**

2. OBJECTIVES / LOCATION

The general aim of this report is to present the results obtained from monitoring air quality at the sampling point defined by JGP Consultoria, located in Villeta, 35 kilometres from the capital Asunción, Paraguay. This point is located approximately 3.5 kilometres from the Puerto Sara industrial complex.

The specific objective of this report is to assess the levels of background values, which are representative values of pre-anthropogenic environmental quality, i.e. before the implementation of the project, in this case the Green Hydrogen production unit to be implemented in Villeta, Paraguay by ATOME, a project subject to an Environmental Impact Assessment (EIA).

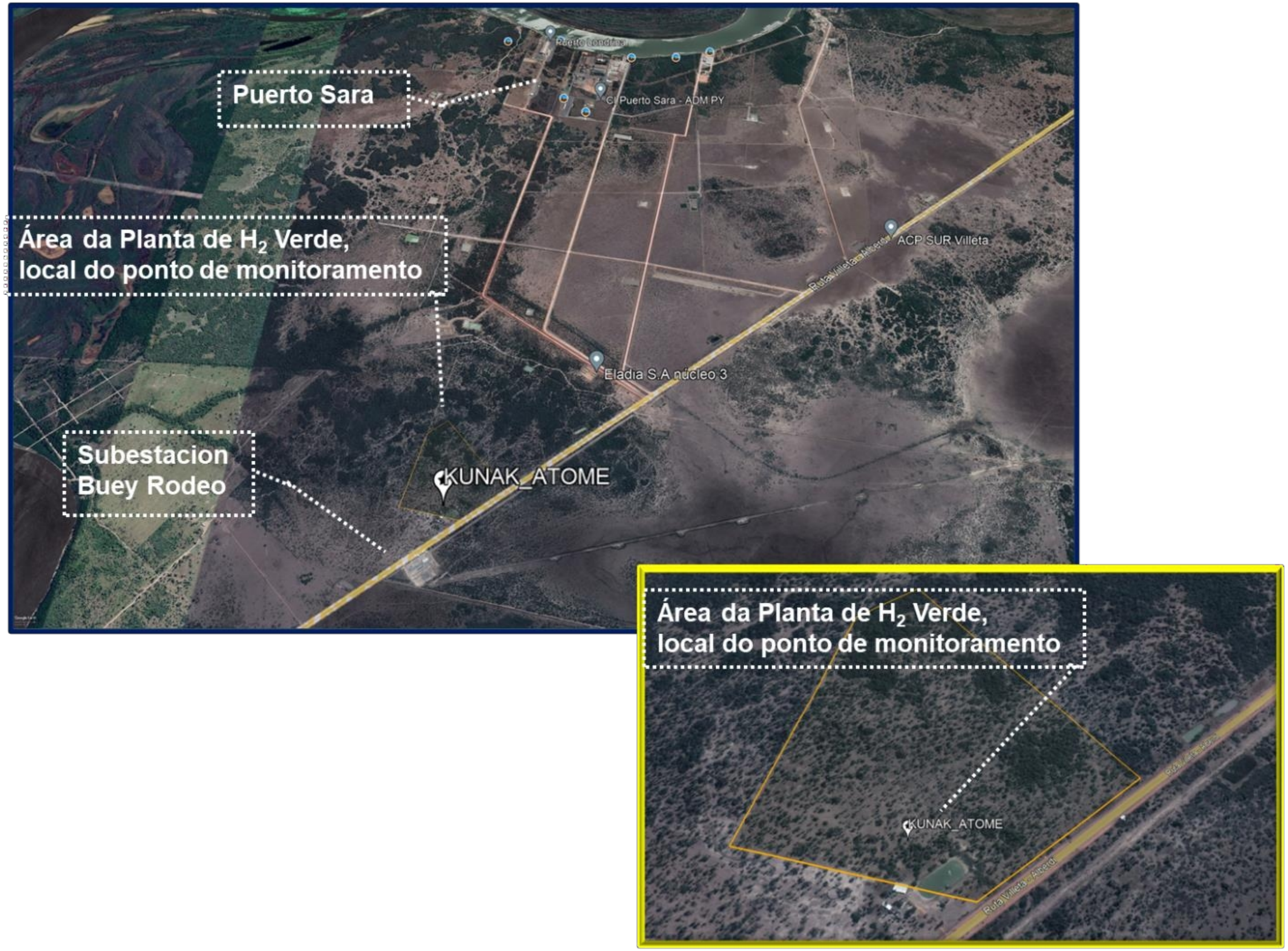
The minimum sampling period established was 18 continuous and uninterrupted days.

Table 1 - Location of the sampling point

Description	**Coordinates in decimal degrees**
Point located on the Ruta Viilleta-Alberdi (Vila Alberdi Route) in front of the Subestacion Buey Rodeo (Buey Rodeo Sub-station). In the area where ATOME's future Green Hydrogen Plant will be installed.	Latitude **- -25.709654º** Longitude **-57.702060º**
Equipment installation date	**Demobilisation of equipment**
11 May 2023 at 17:00 hs.	03 June 2023.

***1 - Parameter legislated in Paraguay - Resolution Nº259/15**

Image 1- Location of the development



Photos

Figure 1 - View of KUNAK from the north

Figure 2 - View of KUNAK from the south

Figure 3 - View of KUNAK in an easterly

directionFigure 4 - View of KUNAK in a westerly direction

***1 - Parameter legislated in Paraguay - Resolution Nº259/15**

3. LIST OF ABBREVIATIONS AND ACRONYMS

- AQG - Global Air Quality Guidelines
- NH_3 - Ammonia
- CO - Carbon Monoxide
- CO_2 - Carbon Dioxide
- ENE - East-Northeast
- EPA - Environmental Protection - Agency
- ESE - East-southeast
- H_2 - Hydrogen
- IQAR - Air Quality Index
- E - East
- PM - Particulate Matter
- N - North
- NE - North-East
- NNE - North-Northeast
- NNO - North-north-west
- NO - North-West
- NO_2 - Nitrogen Dioxide
- O - West
- O_3 - Ozone
- WHO - World Health Organisation
- ONO - west-north-west
- OSO - west-south-west
- PM_{10} - Inhalable material with an equivalent diameter of 10µm
- $PM_{2.5}$ - Inhalable material with an equivalent diameter of 2.5µm
- PTS - Total Suspended Particles with an equivalent diameter of 100µm
- S - South
- SE - South East
- SEAM - Secretariat of the Environment of Paraguay
- SO - South-west
- SO_2 - Sulphur dioxide
- SSE - south-southeast
- SSO - south-south-west
- WHO - World Health Organisation

***1 - Parameter legislated in Paraguay - Resolution Nº259/15**

4. WEATHER CONDITIONS

Villeta is geographically located at a latitude where rainfall is most intense from January to April and least intense from June to August, according to the document: The climate of Villeta (Paraguay), https://es.wikipedia.org/wiki /Villeta (Paraguay). The climate in the Villeta region is moderate and humid. The maximum temperature in summer is 40°C, which is sometimes exceeded. The minimum in winter is 0°C and the average is 30°C.

The climate of the Villeta region as a whole is divided into three types of climate:

a) Humid subtropical in the southern part of the eastern region;
b) Tropical savannah in the west and north of the east;
c) Hot semi-arid climate in the north-west of the Chaco.

According to the Köppen climate classification. The average annual temperature in the region fluctuates between 20 ºC and 25 ºC. Although rainfall is common throughout most of the territory, the amount of 1,400mm varies depending on the region in question, although summer is the season with the highest frequency of rainfall.

During the monitoring period, the predominant winds were between the East-Northeast (ENE) and East-Southeast (ESE) quadrants, with the greatest predominance in the East (E) and East-Northeast (ENE) directions, between 25 and 30 per cent in each direction, which together total approximately 60 per cent of the predominant wind.

The average wind speed was 0.51m/s, with the highest wind speed being 4.49m/s on 22 May 2023, and periods of calm always occurred at night and in the early hours of the morning. The average temperature was 20.3ºC and the maximum was 31.27ºC, the average relative humidity was 81.25% and the average atmospheric pressure was 758mmHg. Annex 12.10 - "Meteorological Parameters" shows instantaneous graphs of the parameters measured.

***1 - Parameter legislated in Paraguay - Resolution Nº259/15**

5. PARAMETERS SAMPLED / METHODOLOGY USED

The parameters defined for monitoring by JGP Consultoria were:

- ✓ Particulate Material
  - o Total Particles (PTS)
  - o Inhalable particles (PM_{10})
  - o Inhalable particles ($PM_{2.5}$)
- ✓ Sulphur dioxide (SO_2);
- ✓ Carbon monoxide (CO);
- ✓ Carbon dioxide (CO_2);
- ✓ Ozone (O_3);
- ✓ Nitrogen dioxide (NO_2).

A **"KUNAK AIR PRO"** Air Quality Monitoring Station was installed to monitor the requested parameters.

This methodology is being widely used in Europe and has been applied in Latin America (Brazil and Paraguay) - *https://kunakair.com/case-studies/*

The "**KUNAK AIR PRO**" monitoring system has the following features:

- ❖ Autonomous pollutant monitoring station and meteorological parameters integrated in the same equipment;
- ❖ Electrochemical sensors for measuring gaseous compounds: Nitrogen Dioxide (NO_2); Ozone (O_3); Sulphur Dioxide (SO_2) and Carbon Monoxide (CO);
- ❖ Integrated non-dispersive infrared sensor (NDIR) to measure the gaseous parameter Carbon Dioxide (CO_2)
- ❖ Optical particle counter for measuring Particulate Matter ($PM_{2.5}$, PM_{10} and PTS)
- ❖ Integrated meteorological sensors: ambient temperature, relative humidity, atmospheric pressure, as well as wind speed and direction;
- ❖ Cloud data storage and management;
- ❖ Power supply via solar panel;
- ❖ Communication via 3G/4G, using a conventional data chip.
- ❖ Management platform for advanced statistical analysis and calculation of the Air Quality Index.

***1 - Parameter legislated in Paraguay - Resolution Nº259/15**

Photo of the Air Quality Monitoring Station - **KUNAK AIR PRO**

Figure 5 - View of the gaseous cartridgesFigure 6 - Front view - OPC

5.1. PRINCIPLES OF MEASUREMENT

5.1.1. Particulate Material

For monitoring Particulate Matter this equipment uses the "laser scattering" measurement principle, which consists of an Optical Particle Counter (OPC) capable of measuring particles from 0.3 µm up to 40 µm. where the particles PTS, PM1, PM2.5 PM4 and PM10 are measured and calculated assuming a particle density profile.

5.1.2. Pollutants gaseous

To monitor the gaseous parameters, this equipment uses cartridges mostly with electrochemical sensors, using nano technology and algorithms to correct interferents, and improve the precision and selectivity of the equipment.

- ✓ For the SO_2 parameter - A built-in electrochemical sensor (cartridge) is used which has high cross-sensitivities with O_3 and NO_2. When used in conjunction with the NO_2 and O_3 cartridges, the Kunak algorithm is able to correct these cross-sensitivities, improving the accuracy of the measurements.

***1 - Parameter legislated in Paraguay - Resolution Nº259/15**

- ✓ For the CO parameter - It uses a cartridge with an integrated electrochemical sensor with noise electronics allowing concentrations to be read in two measurement ranges: Type A - Very low concentrations (ppb) down to several ppm, and Type B - Higher range concentrations that can measure up to 500 ppm. This cartridge is very stable over time with a service life that can go beyond what is specified.
- ✓ For the CO_2 parameter - Uses a cartridge with an integrated non-dispersive infrared sensor (NDIR) ideal for measuring low to high concentrations that can be found in the atmosphere. In addition, it includes an automatic baseline calibration to maintain long-term stability now with the effect of humidity, temperature and pressure, which are corrected in the algorithm.
- ✓ For the O_3 parameter - The ozone cartridge has an integrated electrochemical sensor that detects NO_2 and O_3 concentrations. That's why, in order to accurately measure the O_3 concentration, it needs to be installed in conjunction with the NO_2 cartridge. Thus, thanks to the Kunak algorithm, it is possible to provide accurate ozone measurements, without the influence of NO_2, even at high temperatures which are related to the higher concentration of O_3 due to solar radiation.
- ✓ For the NO_2 parameter - The cartridge has an integrated electrochemical sensor, with an inbuilt ozone filter, to correct for interference from this pollutant (ozone), making the cartridge ideal for measuring concentrations found in the atmosphere, from very low levels in clean environments to high concentrations in polluted areas of cities or industries.

***1 - Parameter legislated in Paraguay - Resolution Nº259/15**

✓

Table 2 - KUNAK AIR PRO technical specifications

KUNAK AIR PRO				
Parameters	**Measurement unit**	**Measuring Range**	**Resolution**	**Limit of Detection**
CO	µg/m³. ppb	0-12,000 ppb(A) 0-500 ppm(B)	1 ppb(A) 0.1 ppm(B)	10 ppb
CO_2	µg/m³. ppm	0-5,000 ppm	1 ppm	
NO_2	µg/m³. ppb	0-5,000 ppb	1 ppb	2 ppb
O_3	µg/m³. ppb	0-2,000 ppb	1 ppb	2 ppb
SO_2	µg/m³. ppb	0-10,000 ppb	1 ppb	5 ppb
PTS	µg/m³	0 - 15,000 µg/m³	1 µg/m˙	-
$PM2_{.5}$	µg/m³	0 - 1,500 µg/m³	1 µg/m˙	
PM_{10}	µg/m³	0 - 2,000 µg/m³	1 µg/m˙	

5.2. OTHER PARAMETERS MEASURED

In addition to the parameters defined for monitoring by JGP Consultoria, the following parameters were also measured:

- ✓ Air Quality Index (IQA) - Dimensional
- ✓ Condensation Point - ºC
- ✓ Humidity - %
- ✓ Inhalable Particle PM1 - µg/m³
- ✓ Inhalable Particle PM4 - µg/m³
- ✓ Atmospheric Pressure - hPa
- ✓ External Temperature - ºC
- ✓ Wind Speed - Average - m/s
- ✓ Wind Speed - Maximum - m/s
- ✓ Wind Direction - Deg

6. AIR POLLUTION / EMISSION SOURCES / HEALTH EFFECTS

Air pollution is associated with atmospheric emissions in urban areas with heavy traffic, industrial areas, areas of agricultural and livestock activities, and areas of

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mining, but also related to natural phenomena such as forest fires and volcanoes

The main effects on human health are

- Particulate Matter (PM) - PM is a common indicator of air pollution. There is strong evidence of the negative health impacts associated with exposure to this pollutant. The main components of PM are sulphates, nitrates, ammonia, sodium chloride, black coal, mineral dust and water.
- Carbon monoxide (CO) - Carbon monoxide is a colourless, odourless and tasteless toxic gas produced by the incomplete combustion of carbon fuels such as wood, petrol, charcoal, natural gas and paraffin.
- Ozone (O_3) - Ground-level ozone, not to be confused with the ozone layer in the upper atmosphere, is one of the main constituents of photochemical smog and is formed by the reaction with gases in the presence of sunlight.
- Nitrogen dioxide (NO_2) - NO_2 is a gas commonly released from the combustion of fuels in the transport and industrial sectors.
- Sulphur dioxide (SO_2) - SO_2 is a colourless gas with a strong odour. It is produced by burning fossil fuels (coal and oil) and smelting sulphur-containing ores.

7. APPLIED LEGISLATION

The values obtained for the requested parameters were compared to the air quality standards established by Resolution Nº259/2015 of the Secretariat of the Environment of Paraguay (SEAM). They were also compared with the WHO Global air quality guidelines (AQG), as last updated in 2021.

The WHO's global air quality guidelines (AQG) provide global guidance on thresholds and limits for the main air pollutants that pose health risks. These guidelines are of high methodological quality and are developed through a transparent, evidence-based decision-making process.

In addition to reference values, the WHO's global air quality guidelines provide interim targets to promote a gradual shift from high to low concentrations. These guidelines are not legally binding standards; however, they provide countries with an evidence-based tool that can be used to inform and support the definition of air quality policies and the development of standards, clean air policies and other tools for air quality management.

POLUENTE	TEMPO MÉDIO	PARAGUAY Resolución Nº259/2015 03/07/15 (µg/m³)	WHO 2021 µg/m³
$PM_{2.5}$	24 horas	30	15
PM_{10}	24 horas	150	45
O_3	8 horas	120	100
NO_2	24 horas	-	25
	1 hora	200	-
SO_2	24 horas	20	40
CO	24 horas	-	4.000
	8 horas	10.000	-

Table 1 - Comparative table of standards from Resolution Nº259/15 and WHO Global air quality guidelines/2021

Air Quality Index (AQI) - This index is a dimensionless numerical value that has been widely used by the US Environmental Agency (EPA) since the early 1980s, created with the aim of easily presenting information about the air quality of a given location to the population.

This index is a daily report in which air quality is classified based on the concentrations of pollutants recorded during the period into five different levels, ranging from good to very bad, and which portray the risks and adverse effects on health that the population is exposed to.

In Paraguay, this index has been used according to EPA standards since 2019.

The KUNAKCLOUD platform automatically calculates the IQA, the IQA calculations for all the legislated parameters presented in this report have been configured for AQI USEPA LAYER.

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EPA - Environmental Pr Agency	IQA	CONTENTS	POLLUTANTS							
			MP_{10} (µg/m³) 24 hours	$MP2_{.5}$ (µg/m³) 24 hours	O_3 (µg/m³) 1 hour	O_3 (µg/m³) 8 hours	CO (ppm) 8 hours	NO_2 (µg/m³) 1 hour	SO_2 (µg/m³) 1 hour	SO_2 (µg/m³) 24 hours
	Good	0 - 50	0 - 54	0 - 12	-	0 - 108	0 - 5038	0 - 99,6	0 - 91,7	-
	Moderate	51 - 100	55 - 154	12 - 35	-	109 - 140	5039 - 10763	99 - 188	91 - 196	-
	Unhealthy for Sensitive Groups	100 - 150	155 - 254	36 - 55	250 - 328	140 - 210	10764 - 14198	189 - 676	197 - 484	-
	Unhealthy	150 - 200	255 - 354	56 - 150	329 - 408	211 - 400	14199 - 17633	677 - 1220	485 - 796	-
	Very Unhealthy	201 - 300	355 - 424	151 - 250	409 - 808	-	17633 - 34808	1221 - 2348	-	799 - 1582
	Hazardous	301 - 500	425 - 604	251 - 500	809 - 1208	-	34809 - 57708	2349 - 3852	-	1583 - 2631

Table 2 - USEPA IQA

8. ANALYSING RESULTS

The results obtained from the air quality monitoring campaign, background values, carried out in the area of the future Green Hydrogen production unit in Villeta, Paraguay, from 12 May 2023 to 2 June 2023, are presented in the form of dynamic graphs, pollution rose and AQI calendar graph, attached to this document.

The air quality index remained **"Good"** throughout the monitoring period, with dimensionless values between 0 and 50, see appendix 12.9 - Calendar Graph - Air Quality Index (AQI).

This value indicates that all the environmental levels of the air pollutants monitored were always below the air quality standards established by the USEPA, since the index was calculated for this institution.

And as can be seen in Annexes 12.1 to 12.8, the environmental levels of monitored and legislated air pollutants were always below the air quality standards established by Resolution Nº259/2015 of the Paraguayan Environment Secretariat and the WHO 2021 Global Air Quality Guidelines.

This corroborates the fundamental aspect of this report: identifying background concentrations in the area of the future Green Hydrogen plant.

***1 - Parameter legislated in Paraguay - Resolution Nº259/15**

Table 3 shows the average, maximum and minimum values of the **instantaneous results** obtained during the monitoring campaign

Table 3 - Instantaneous pollutant values

Resultados "Instantâneos" do Monitoramento da Qualidade do Ar do periodo monitorado						Padrões de Qualidade do Ar			
Poluentes	Unidade	Valor Máximo *2	Valor Médio *1	Valor Mínimo	Desvio Padrão	SEAM (2015)	Tempo Médio	WHO (2021)	Tempo Médio
$PM_{2.5}$	µg/m³	94,54	5,06	0,32	6,30	30	24 hs	15	24 hs
PM_{10}	µg/m³	135,58	8,82	0,60	9,16	150	24 hs	45	24 hs
PTS	µg/m³	280,96	12,27	0,61	14,62	-	-	-	-
SO_2	ppb	17,53	0,11	0,00	0,89	7,6	24 hs	15,3	24 hs
O_3	ppb	49,74	11,69	0,00	11,30	61	8 hs	51	8 hs
NO_2	ppb	14,27	0,46	0,00	1,47	106	1 h	13,3	24 hs
CO	ppm	0,67	0,24	0,03	76,18	8,7	8 hs	3,5	24 hs
CO_2	ppm	616,49	478,76	414,38	37,97	-	-	-	-

*1 - Valor Médio de todo periodo de amostragem (18 dias)

*2 - Valor Máximo - Pico, amostragens de 10 em 10 minutos

8.1. Dynamic graphics

a) $PM2_{.5}$ - 24-hour average*1
b) PM10 - 24-hour average*1
c) PTS - 24-hour average
d) O3 - Average of 8 hours*1
e) NO2 - 1 hour average*1
f) NO2 - 24-hour average
g) SO2 - 24-hour average*1
h) CO - Average of 8 hours*1
i) CO - 24-hour average
j) CO2 - 24-hour average

8.2. Rosa from Pollution

The Pollution Rose shows the values obtained for the monitored pollutant and the prevailing wind direction at the time of monitoring.

a) $PM_{2.5}$ - 24-hour average*1
b) PM_{10} - 24-hour average*1
c) PTS - 24-hour average

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d) O_3 - Average of 8 hours*1
e) NO_2 - Average of 1 hour*1
f) SO_2 - 24-hour average*1
g) CO - Average of 8 hours*1

8.3. Calendar graphic AQI

The AQI calendar graph shows the values obtained for the Air Quality Index (USEPA) during the campaign for the legislated pollutants.

9. CONCLUSION

The results obtained in the campaign carried out in the area of ATOME's future Green Hydrogen plant were aimed at characterising the presence of pollutants and their dispersion in the area analysed. As can be seen, throughout the monitoring period, the index (IQA) widely used to easily present information on air quality, indicated **"Air Quality - GOOD"**, and the environmental levels of the atmospheric pollutants monitored were always below the air quality standards established by Resolution Nº259/2015 of the Paraguay Environment Secretariat and the WHO 2021 Global Air Quality Guidelines.

10. TEAM TECHNICAL

Data processing

✓ Jurandir R. Brito - Senior Consultant, Air Quality Specialist - CREA/BA 47634

Drafting / Proofreading / Formatting/Validation

✓ Jurandir R. Brito - Senior Consultant, Air Quality Specialist - CREA/BA 47634

***1 - Parameter legislated in Paraguay - Resolution Nº259/15**

Preparation / Review / Formatting of meteorological data

✓ Meteorologist Silvio de Oliveira - MSc. CREA-SP Nº0600948501

Silvio de Oliveira

11. BASE OF DATA

- KunakCloud
- World Health Organisation (2021). WHO global air quality guidelines: particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. World Health Organisation. https://apps.who.int/iris/handle/10665/345329. Licence: CC BY-NC-SA 3.0 IGO
- Environmental, Health, and Safety Guidelines - General EHS Guidelines: Environmental - Air Emissions and Ambient Air Quality - IFC (International Finance Corporation)
- Guidelines for Ensuring and Maximising the Quality, Objectivity, Utility and Integrity of Information Disseminated by the EPA (Environmental Protection Agency).
- Resolution Nº259/2015 - Secretariat of the Environment - Paraguay.
- https://kunakair.com/case-studies/
- *Diagnosis of air pollution by nitrogen oxides in the city of Asunción Nuestra Señora de la Asunción Catholic University* https://www.researchgate.net/publication/289994180_Diagnostico_de_la_contaminacion_del_aire_por_oxidos_de_nitrogeno_en_la_ciudad_de_Asuncion

***1 - Parameter legislated in Paraguay - Resolution Nº259/15**

12. ANNEXES

12.1. $PM_{2.5}$ - Dynamic charts, Pollution Rose and Calendar chart.

12.2. PM_{10} - Dynamic charts, Pollution Rose and Calendar chart.

12.3. PTS - Dynamic Charts, Pollution Rose and Calendar Chart.

12.4. O_3 - Dynamic charts, Pollution Rose and Calendar chart.

12.5. NO_2 - Dynamic Charts, Pollution Rose and Calendar Chart.

12.6. SO_2 - Dynamic charts, Pollution Rose and Calendar chart.

12.7. CO - Dynamic Charts, Pollution Rose and Calendar Chart.

12.8. CO_2 - Dynamic charts, Pollution Rose and Calendar chart.

12.9. Calendar Chart - Air Quality Index (AQI).

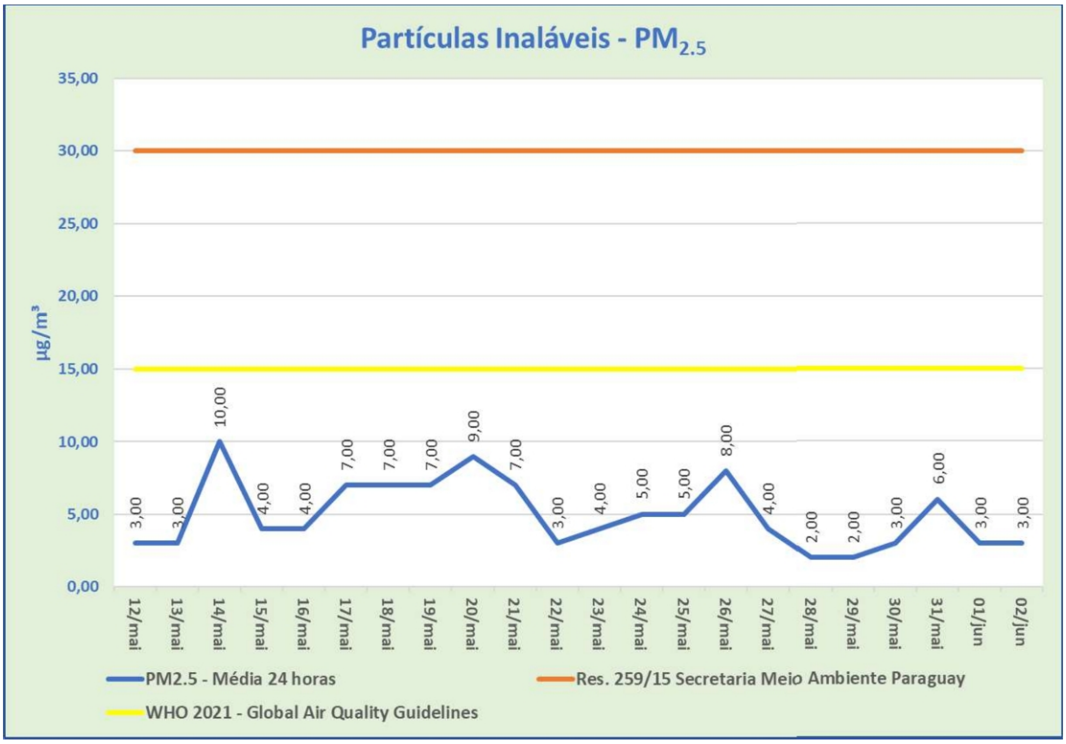
12.10. Meteorological parameters (WS, Humidity, Pressure and Temperature)

12.11. Sensor calibration certificates.

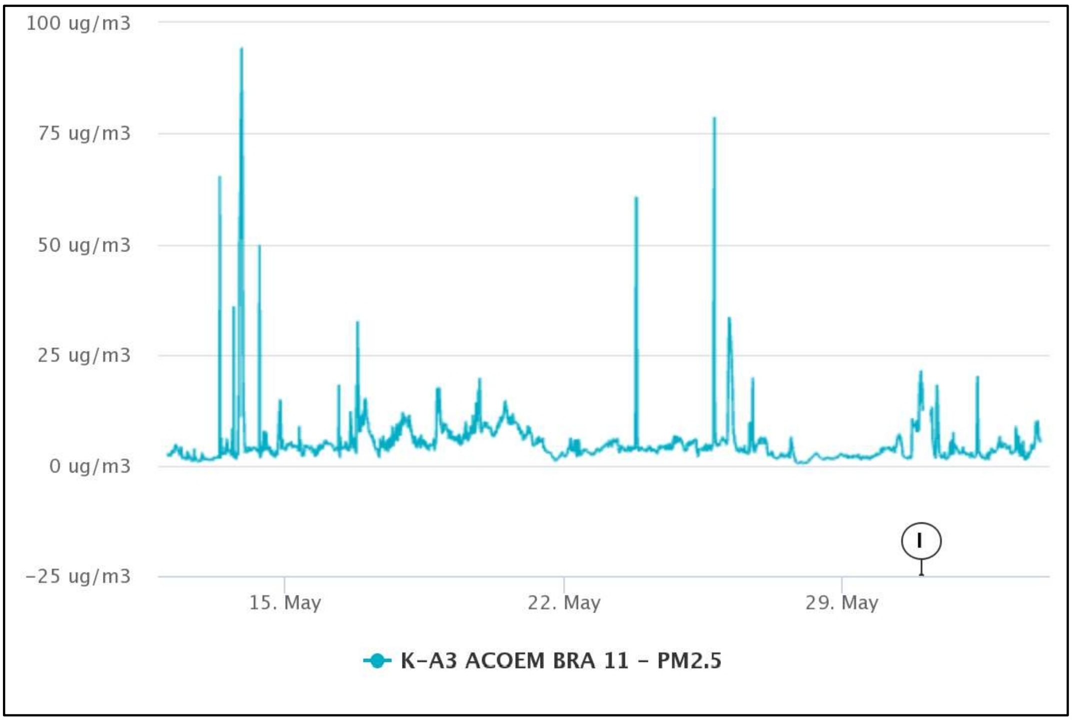
12.12. Technical Responsibility Certificate - ART

***1 - Parameter legislated in Paraguay - Resolution Nº259/15**

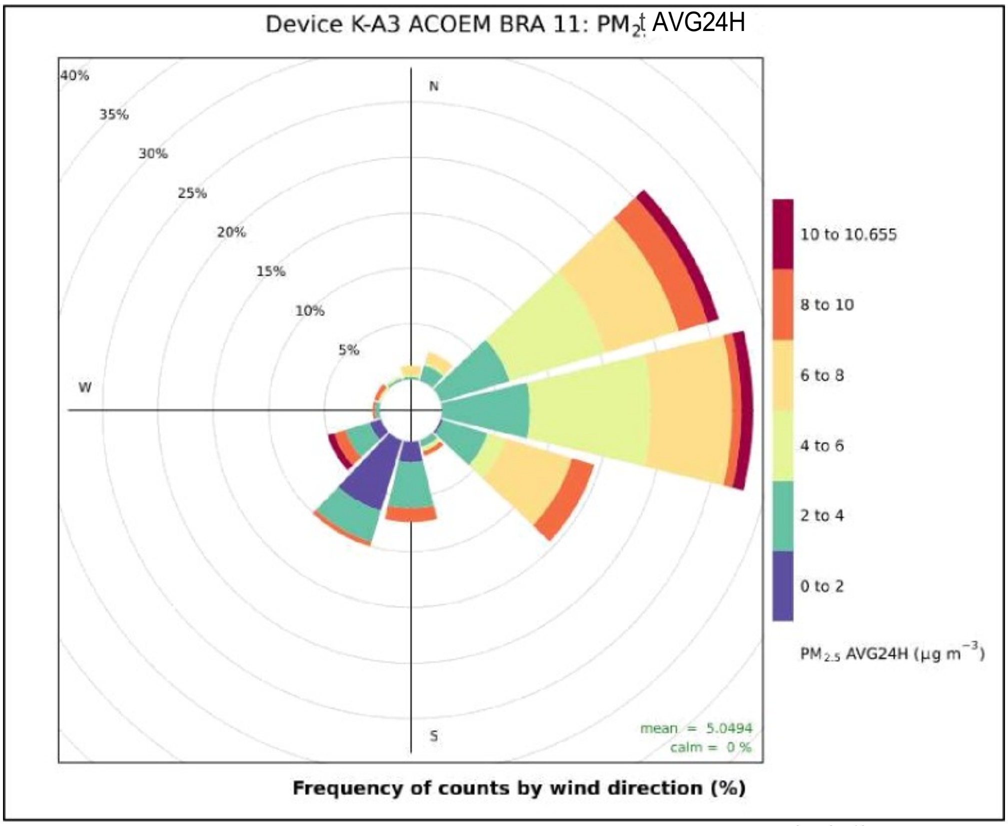
ANNEX 12.1 - PM$_{2.5}$– Dynamic graphs and Pollution Rose.



12.1.1 – Partícula Inalável PM$_{2.5}$ – Média 24 horas (µg/m³)

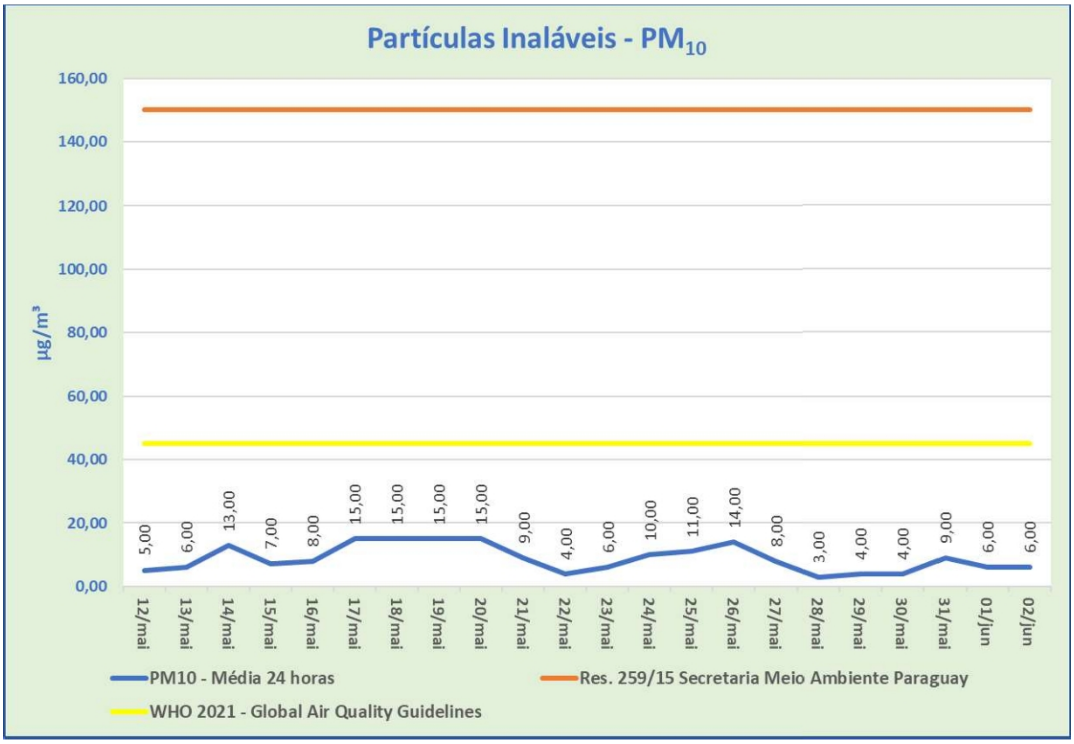


12.1.2 - Partícula Inalável PM$_{2.5}$ – Amostragem Instantânea (µg/m³)

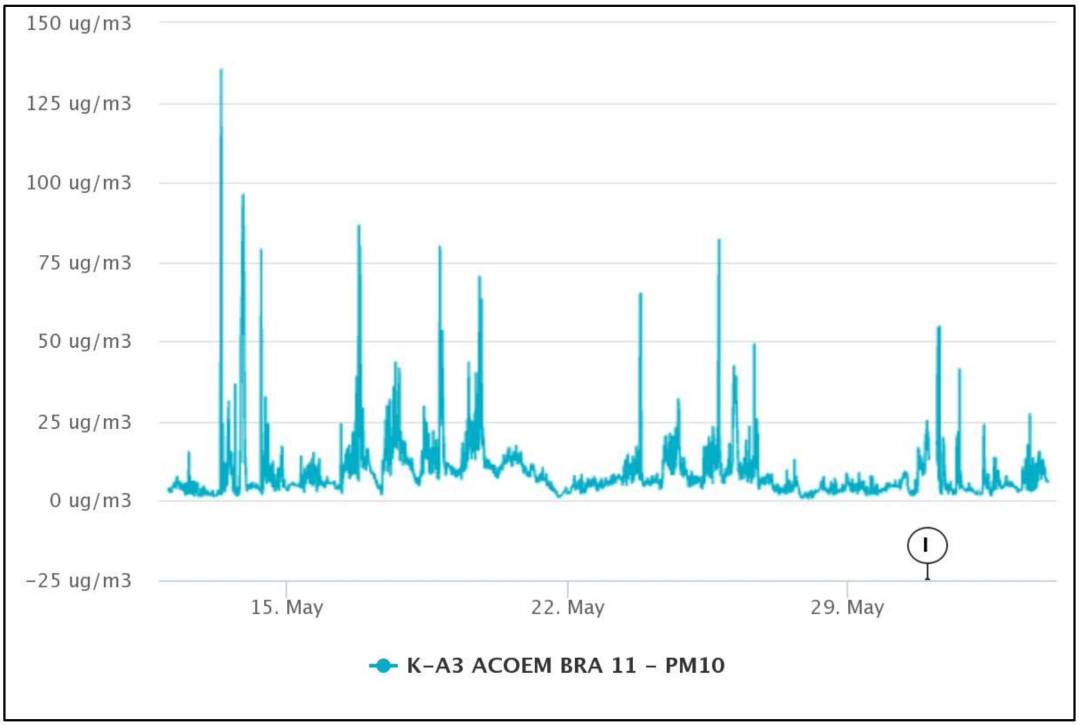


12.1.3 - Inhalable particle PME.s - 24 h average - Pollution Rose (pg/m°)

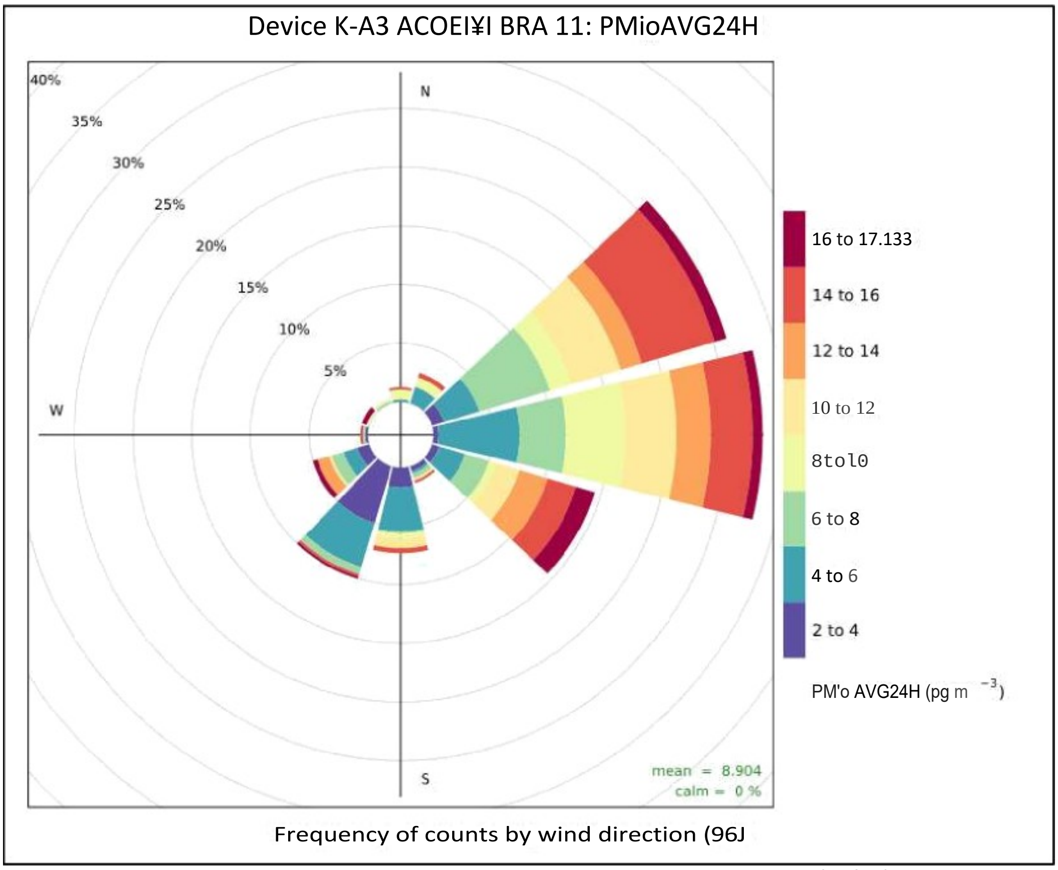
ANNEX 12.2– PM10– Dynamic graphs and Pollution Rose.



12.2.1 – Partícula Inalável PM_{10} – Média 24 horas (µg/m³)

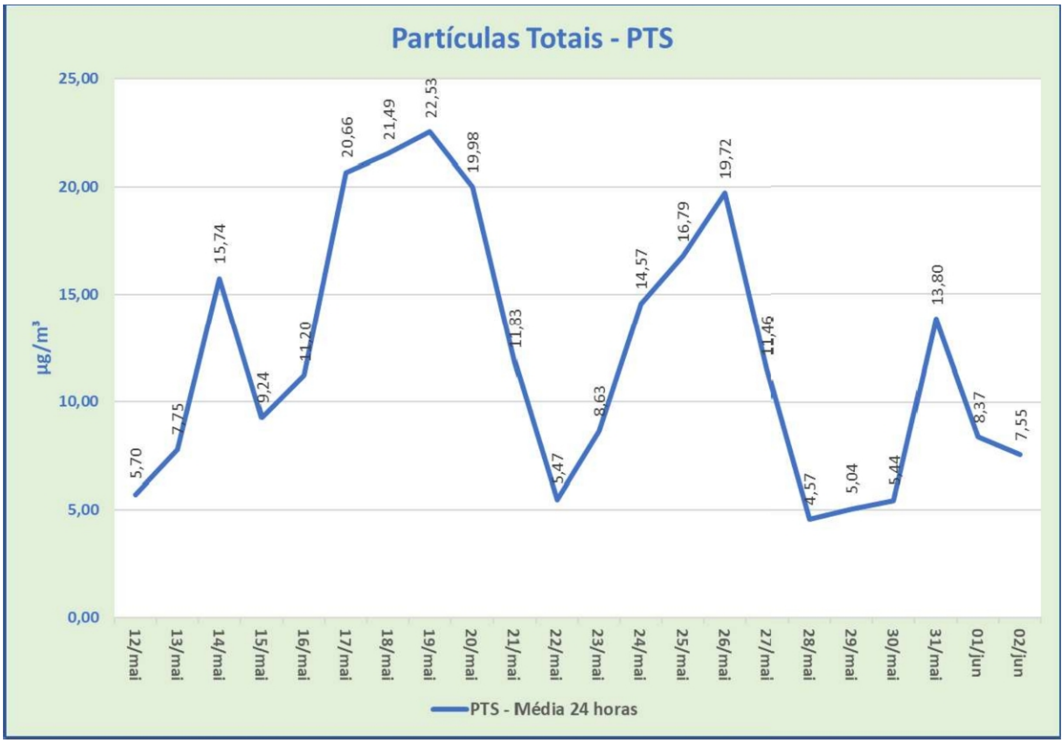


12.2.2 - Partícula Inalável PM_{10} – Amostragem Instantânea (µg/m³)

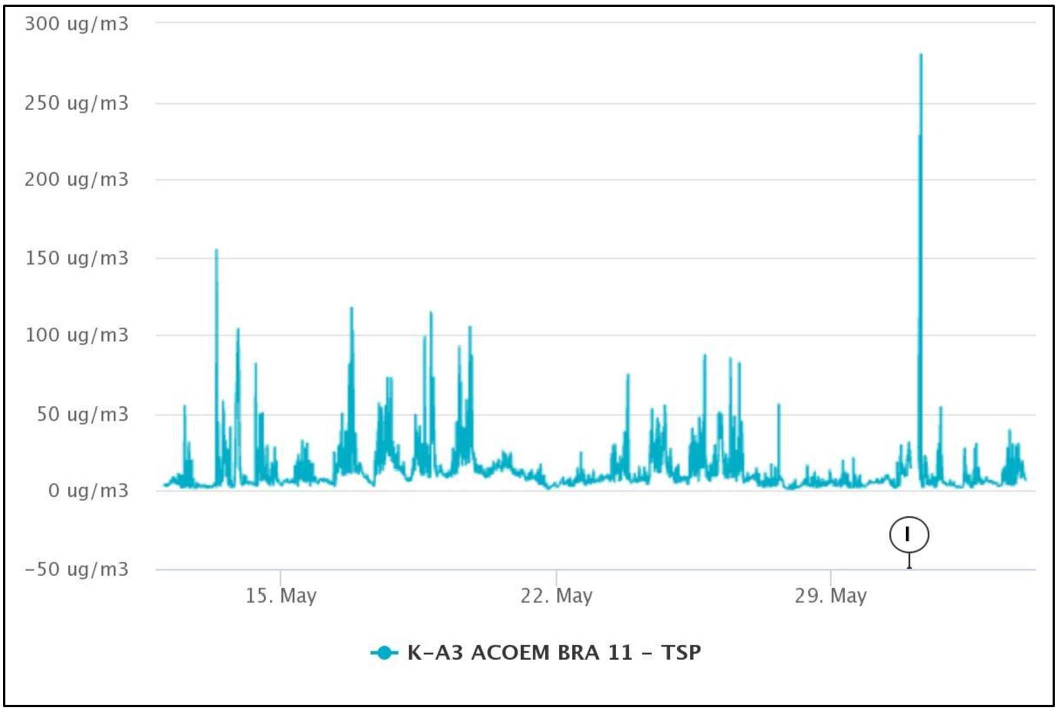


12.2.3 - Inhalable Particle PM10 - 24 h Average - Pollution Rose (pg/m)a

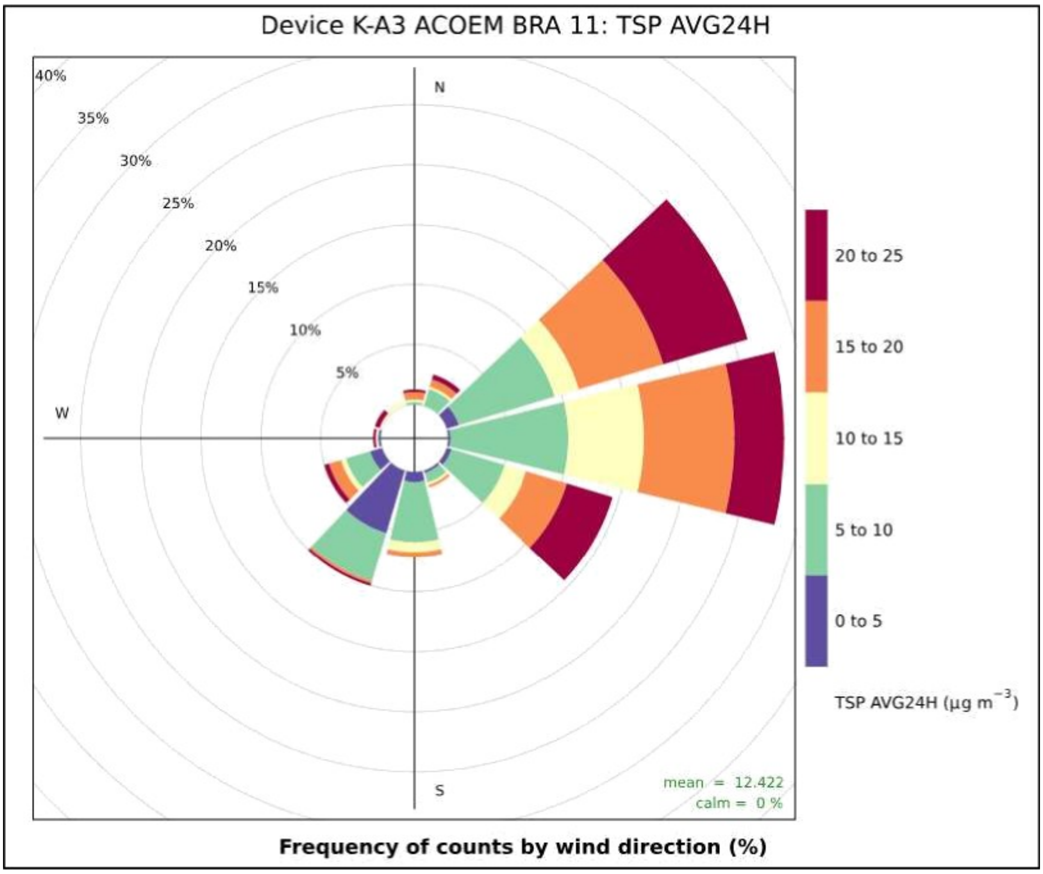
ANNEX 12.3– PTS– Dynamic graphics and Pollution Rose.



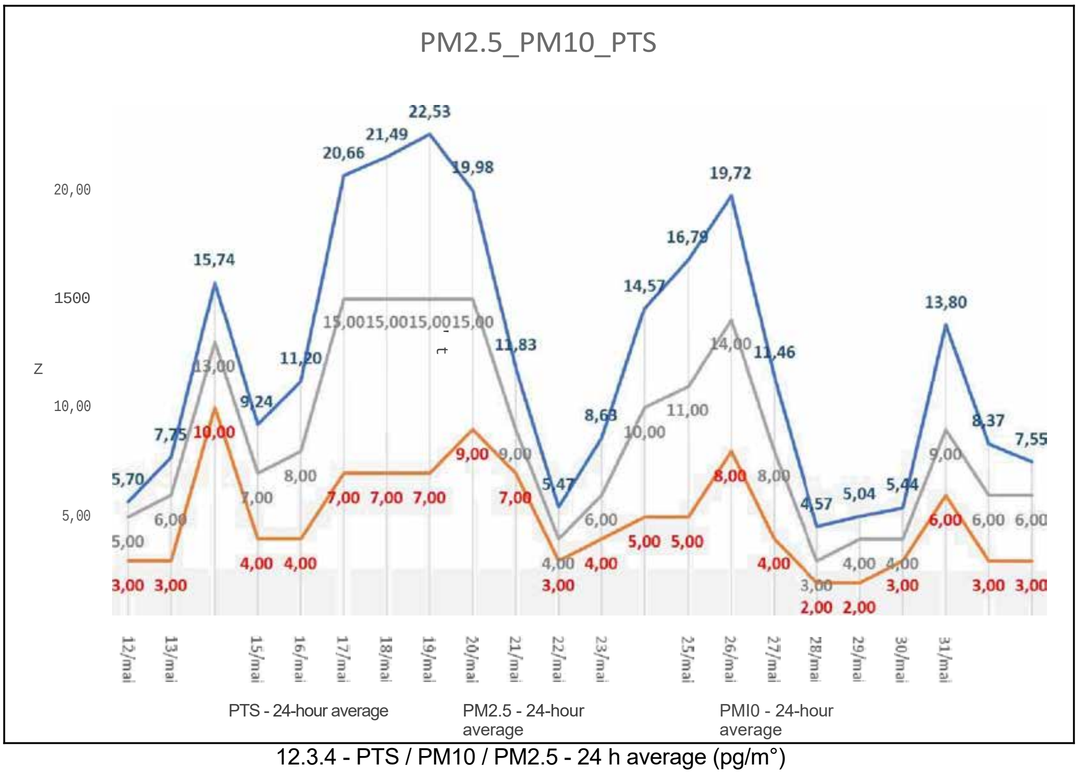
12.3.1 – Partículas Totais PTS – Média 24 horas (µg/m³)



12.3.2 – Partículas Totais PTS – Amostragem Instantânea (µg/m³)

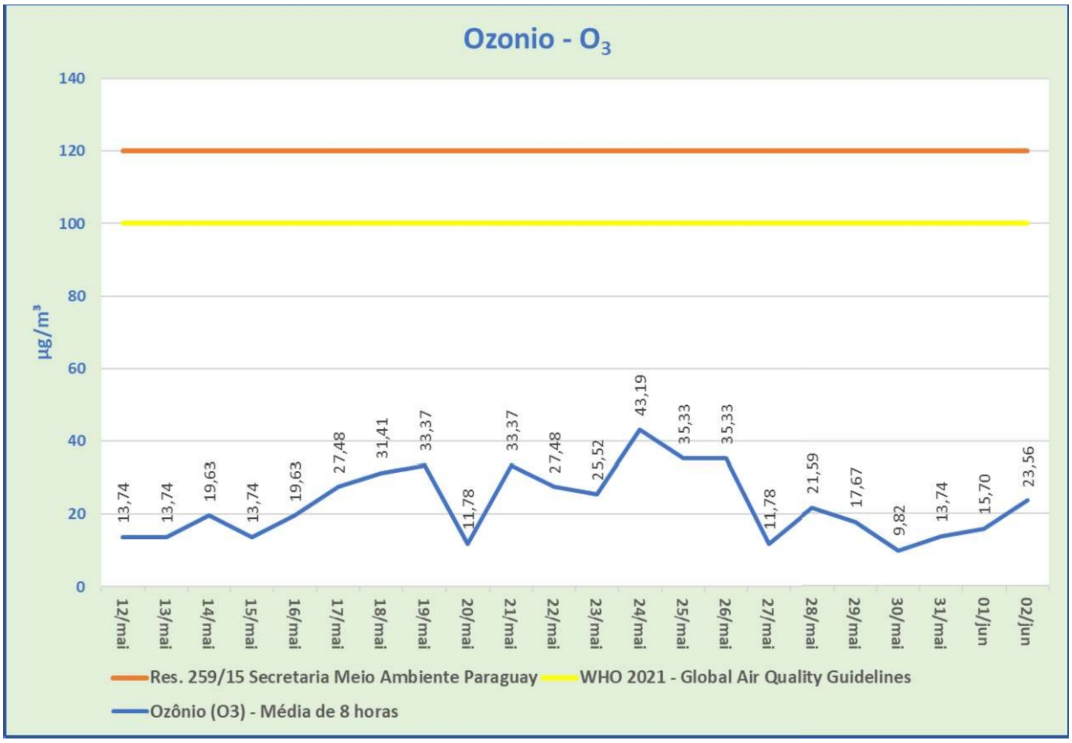


12.3.3 - Total Particles PTS - 24 h Average - Pollution Rose (pg/m°)

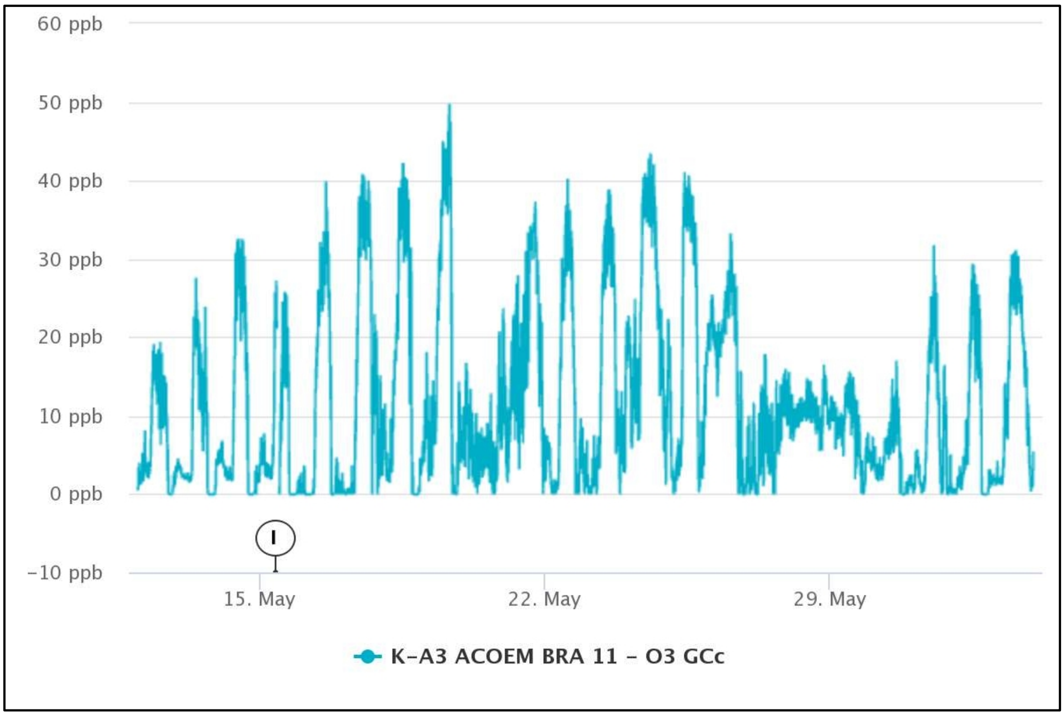


12.3.4 - PTS / PM10 / PM2.5 - 24 h average (pg/m°)

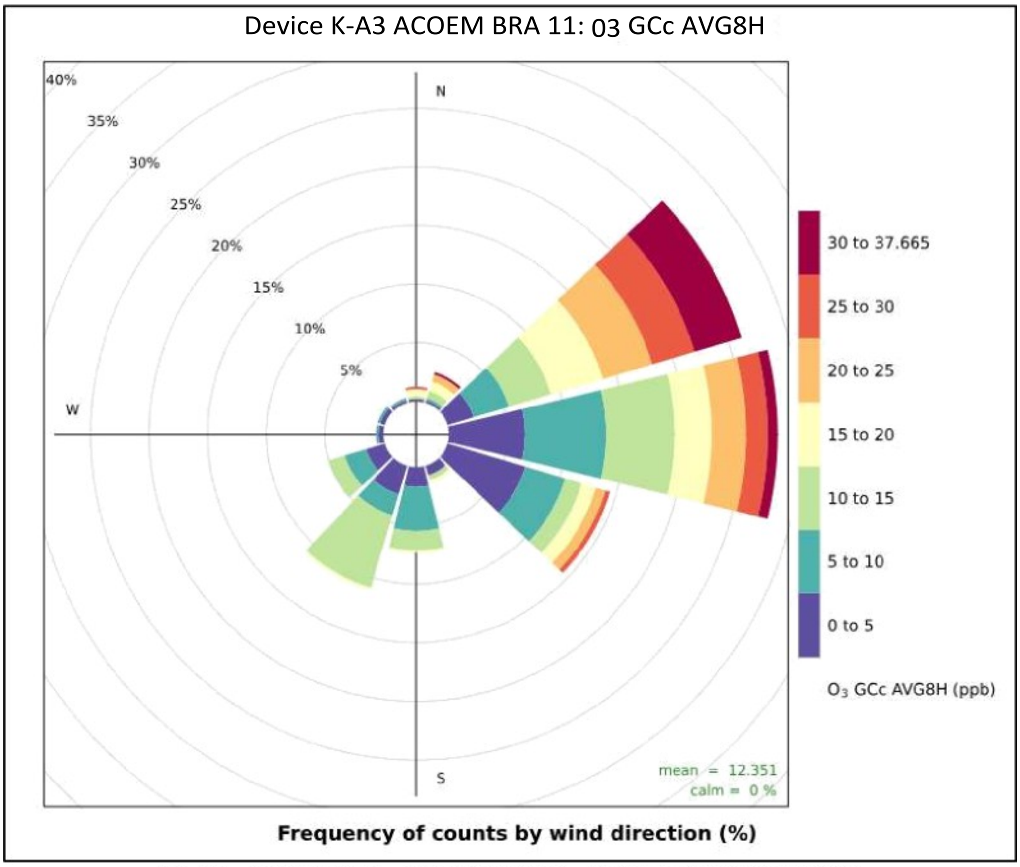
ANNEX 12.4– O_3– Dynamic graphics and Pollution Rose.



12.4.1 – Ozônio (0_3) – Média 8 horas (µg/m³)

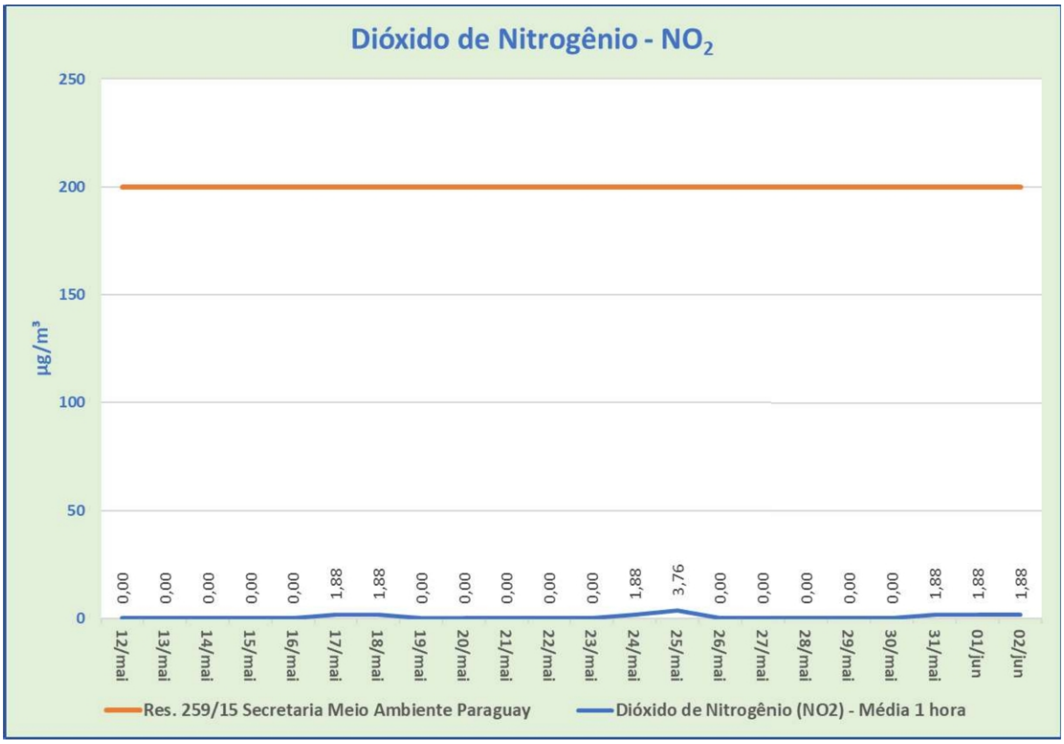


12.4.2 – Ozônio (0_3) – Amostragem Instantânea (ppb)

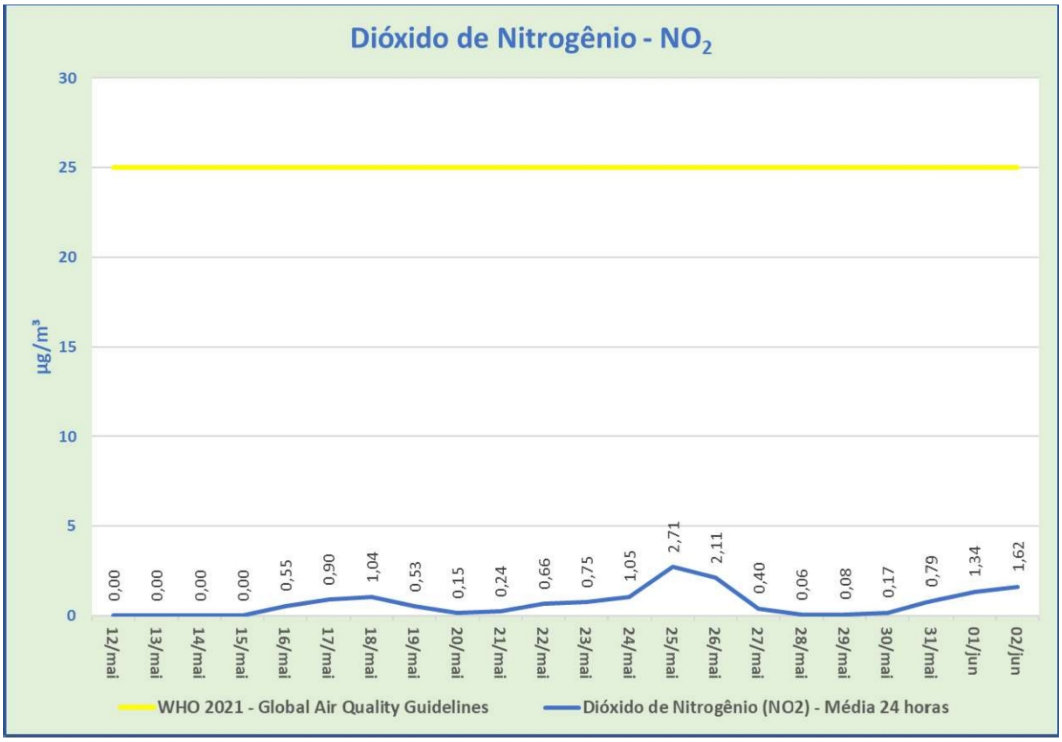


12.4.3 – Ozônio (0₃) – Média 8 horas – Rosa de Poluição (ppb)

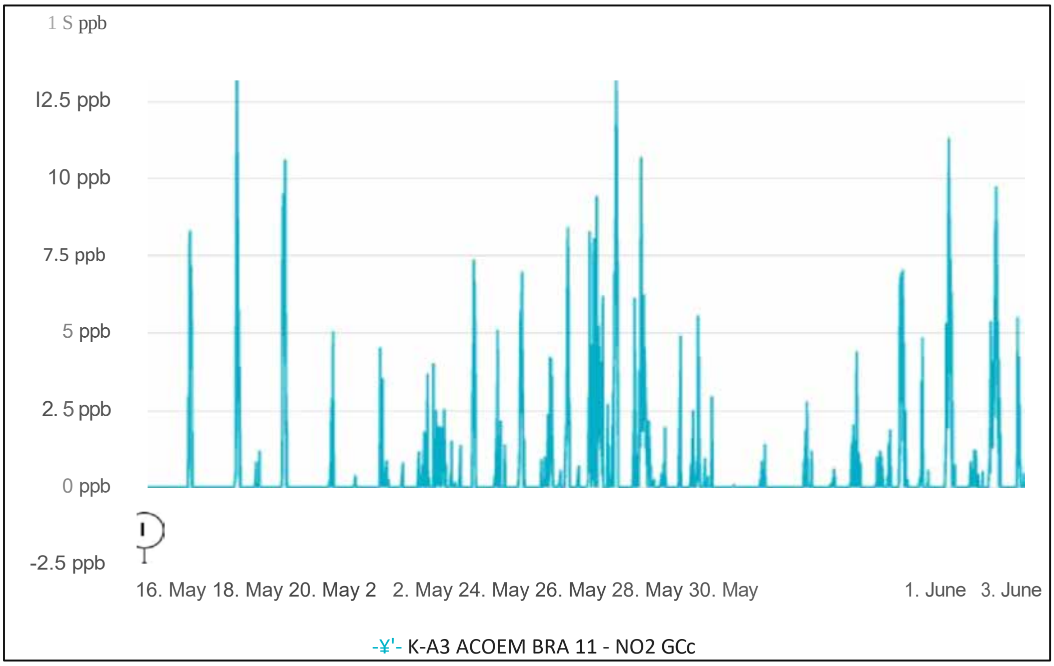
ANNEX 12.5– NO_2– Dynamic graphs and Pollution Rose.



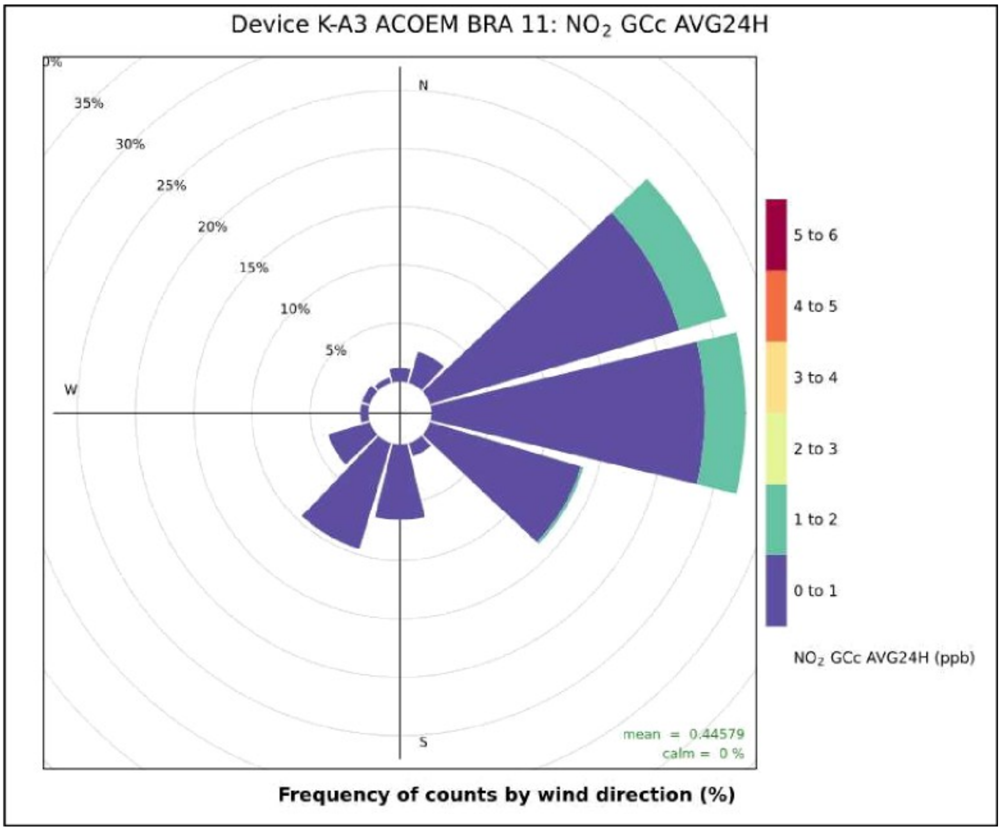
12.5.1 – Dióxido de Nitrogênio NO_2 – Média 1 hora (µg/m³)



12.5.2 – Dióxido de Nitrogênio NO_2 – Média 24 horas (µg/m³)

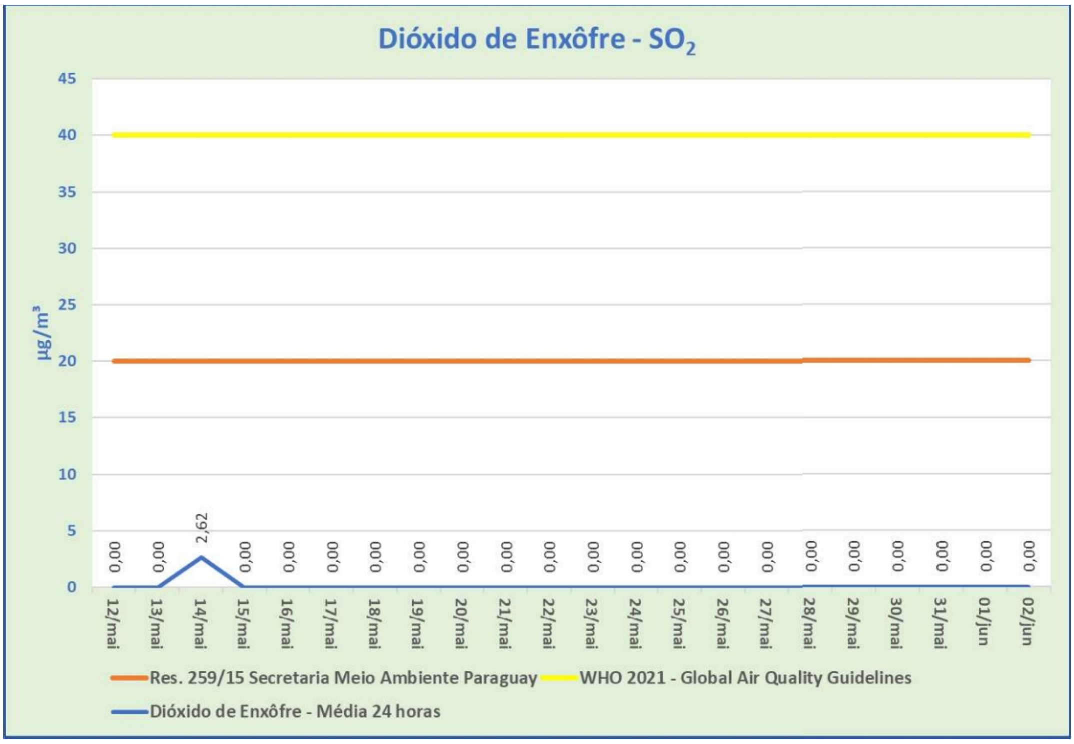


12.5.3 - Nitrogen Dioxide NO2 - Instantaneous Sampling (ppb)

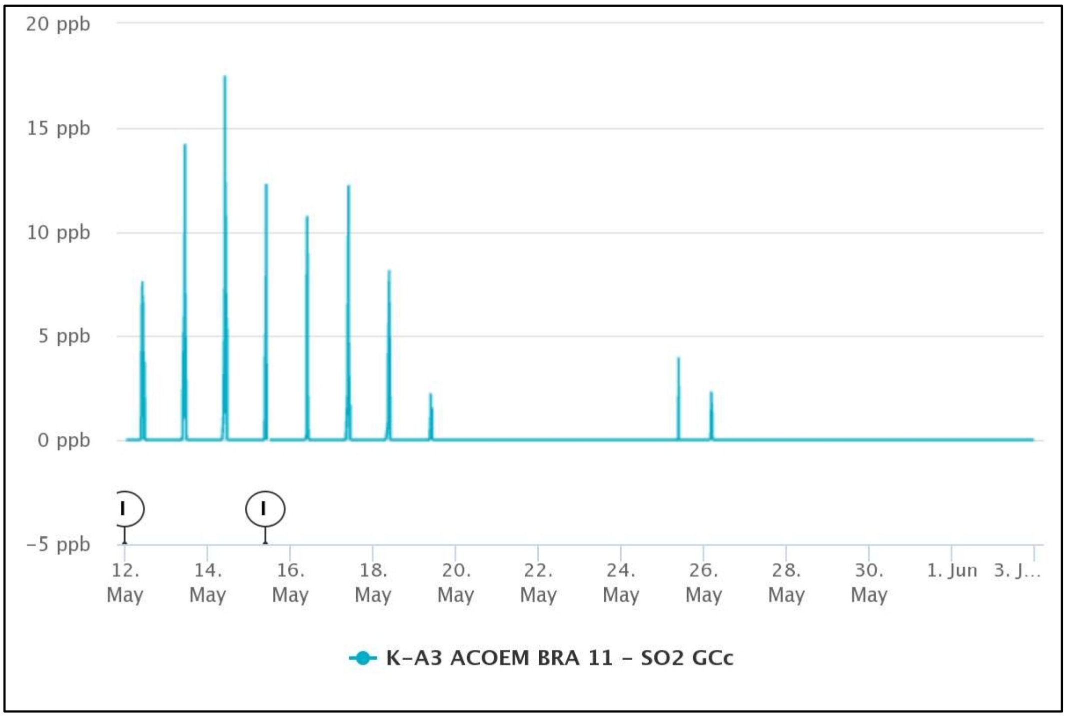


12.5.4 - Nitrogen Dioxide NO2 - 24 hour average - Pollution Rose (ppb)

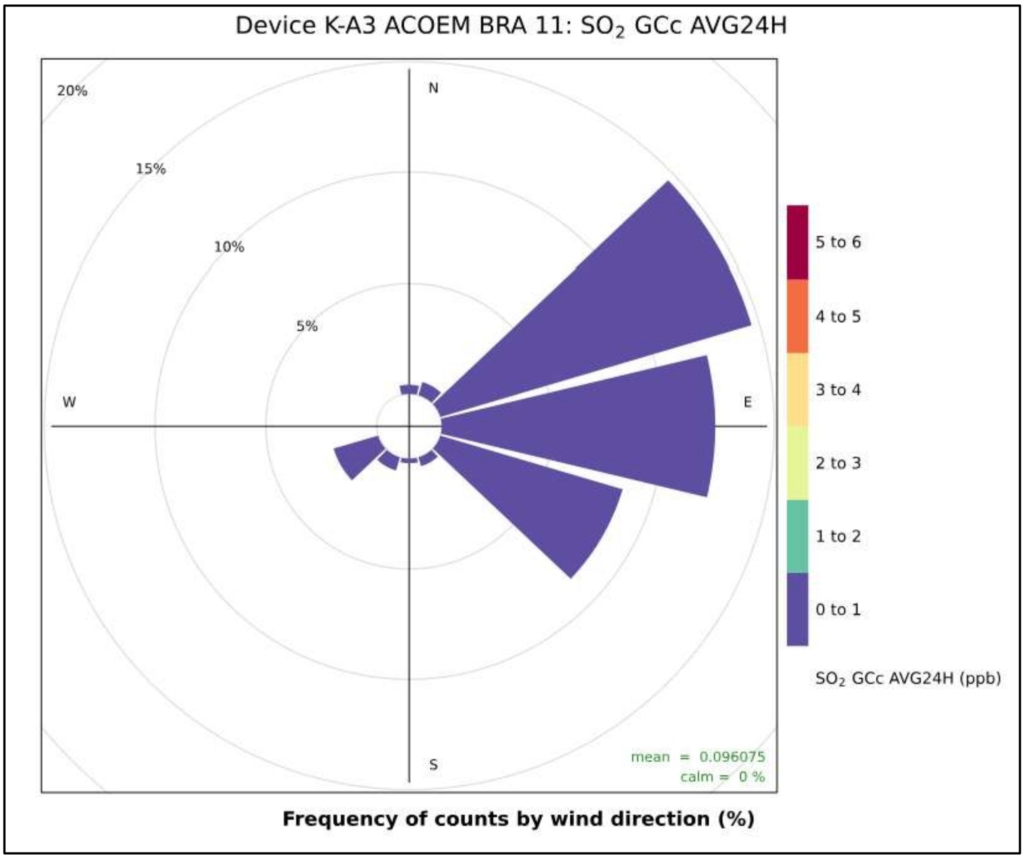
ANNEX 12.6– SO_2– Dynamic graphs and Pollution Rose.



12.6.1 – Dióxido de Enxofre SO_2 – Média 24 horas (µg/m³)

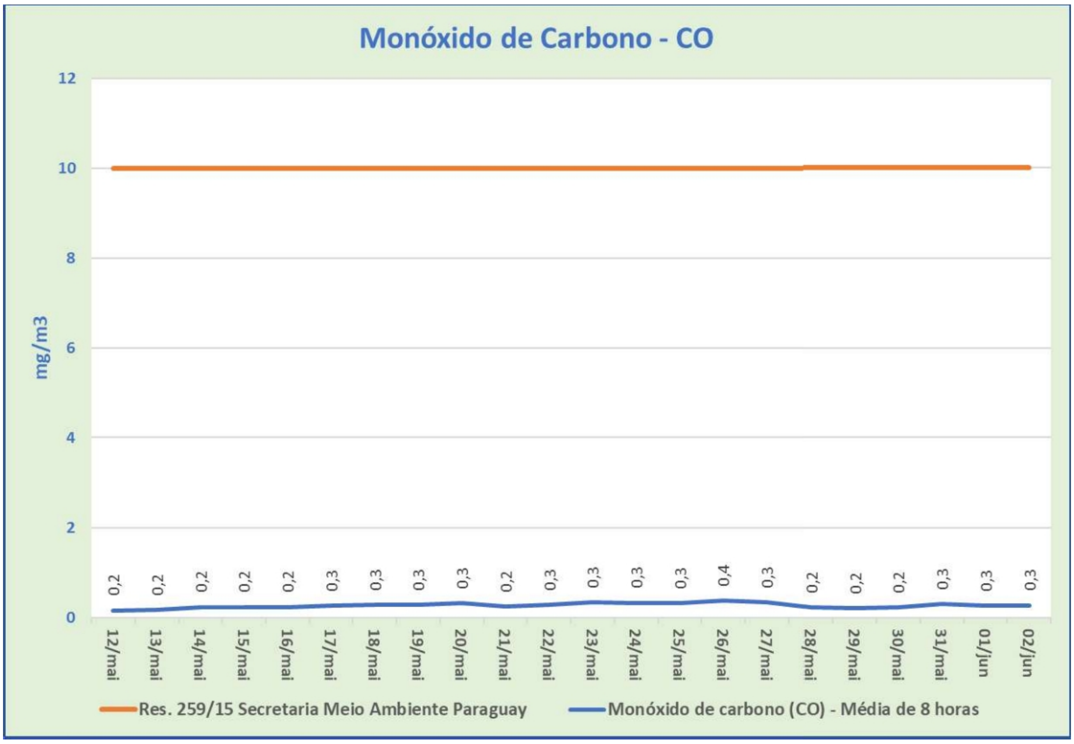


12.6.2 – Dióxido de Enxofre SO_2 – Amostragem Instantânea (ppb)

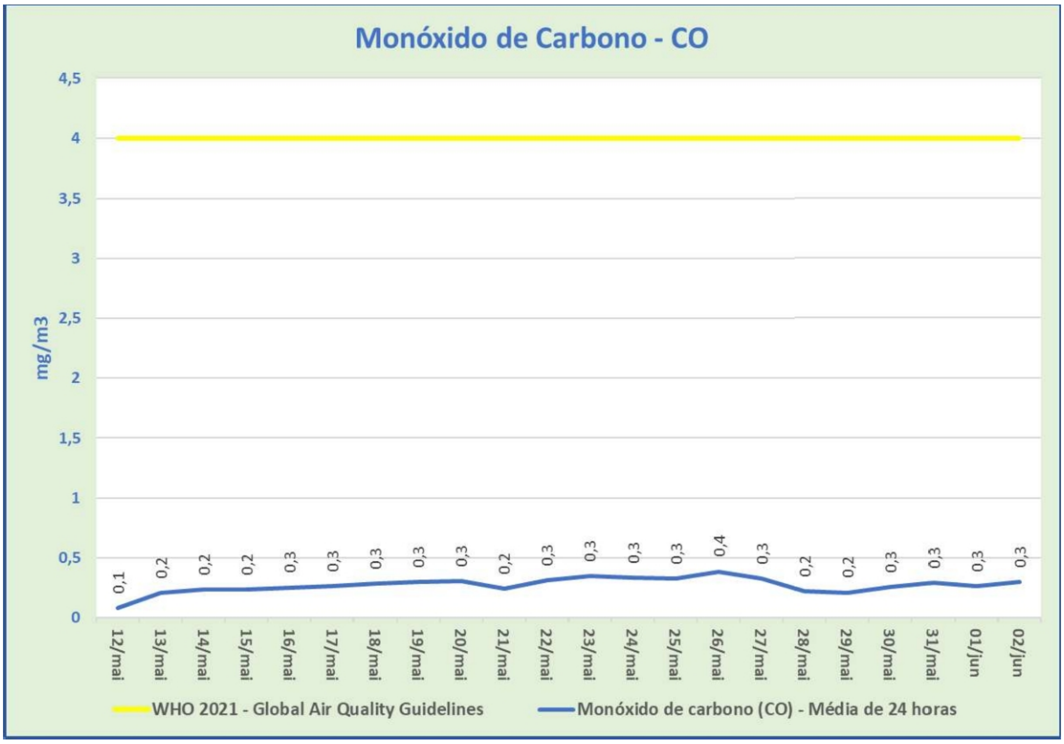


12.6.3 – Dióxido de Enxofre SO_2 – Média 24 horas – Rosa de Poluição (ppb)

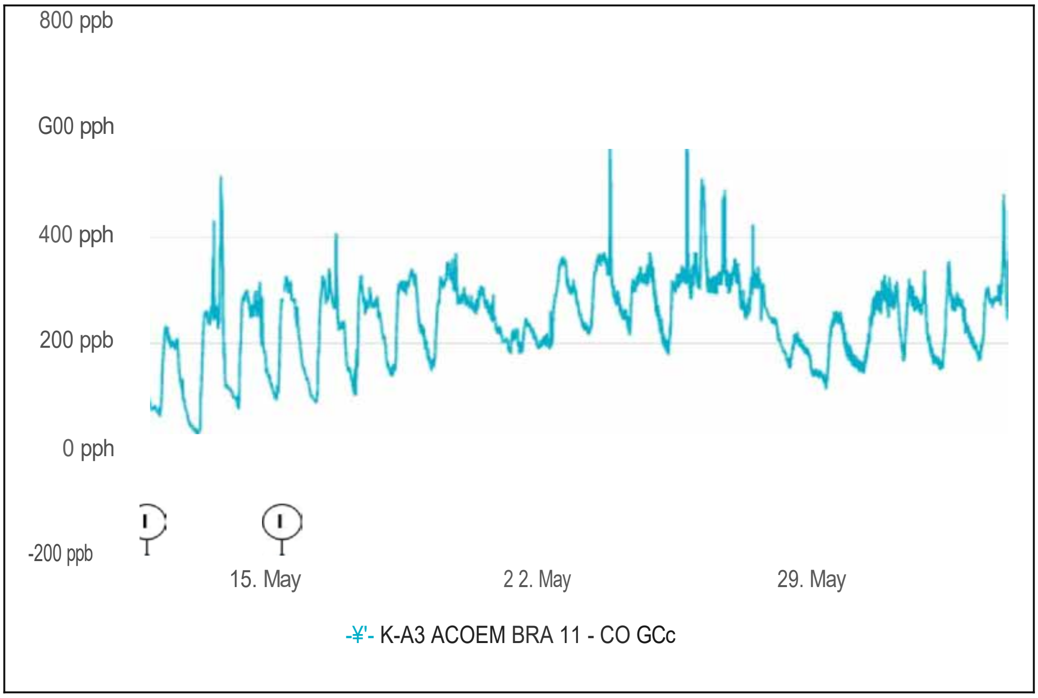
ANNEX 12.7– CO– Dynamic graphics and Pollution Rose.



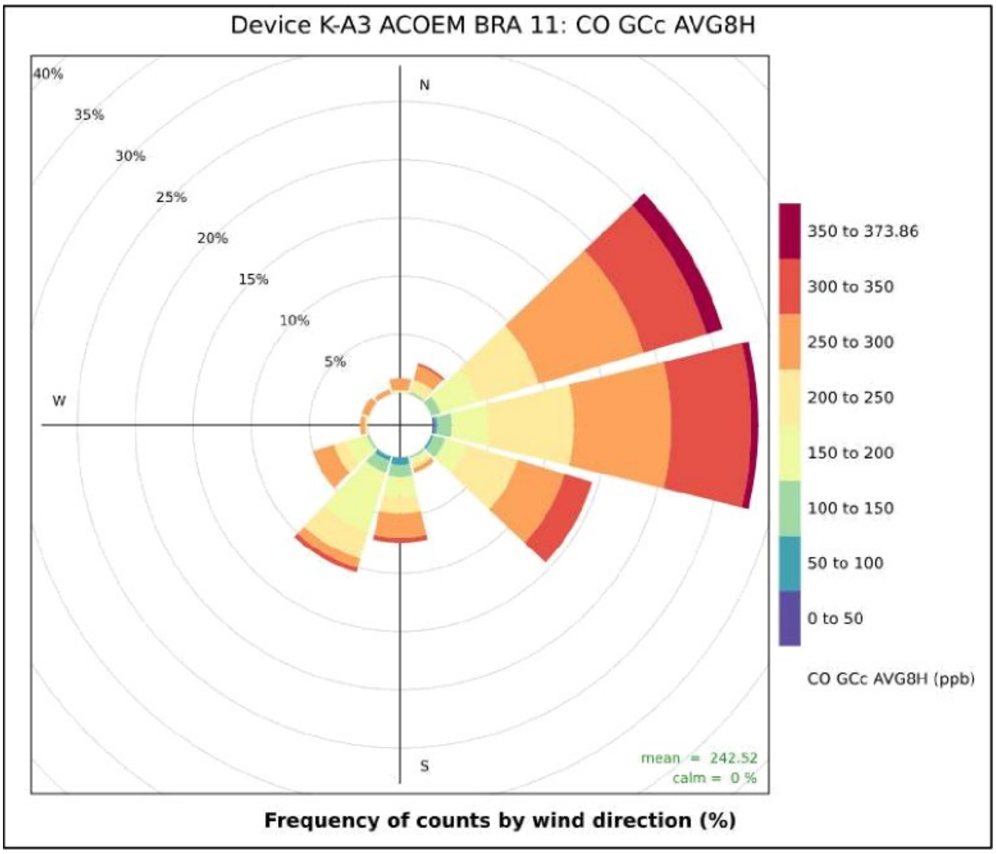
12.7.1 – Monóxido de Carbono CO – Média 8 horas (mg/m³)



12.7.2 – Monóxido de Carbono CO – Média 24 horas (mg/m³)

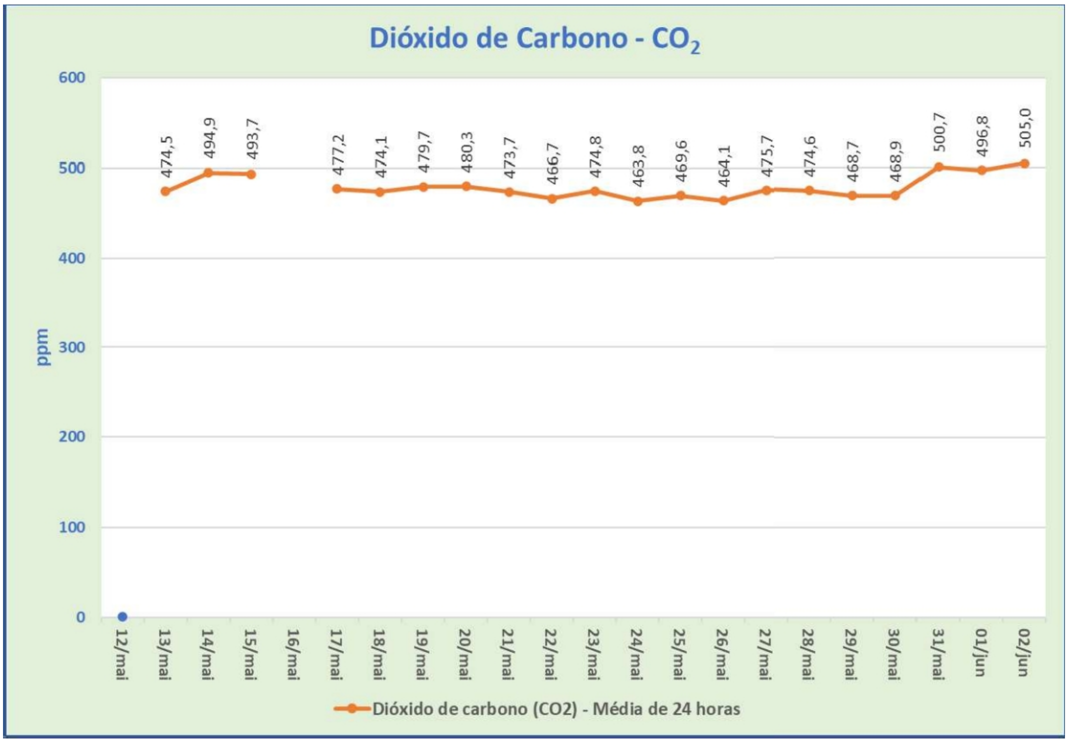


12.7.3 - Carbon Monoxide CO - Instant Sampling (ppb)

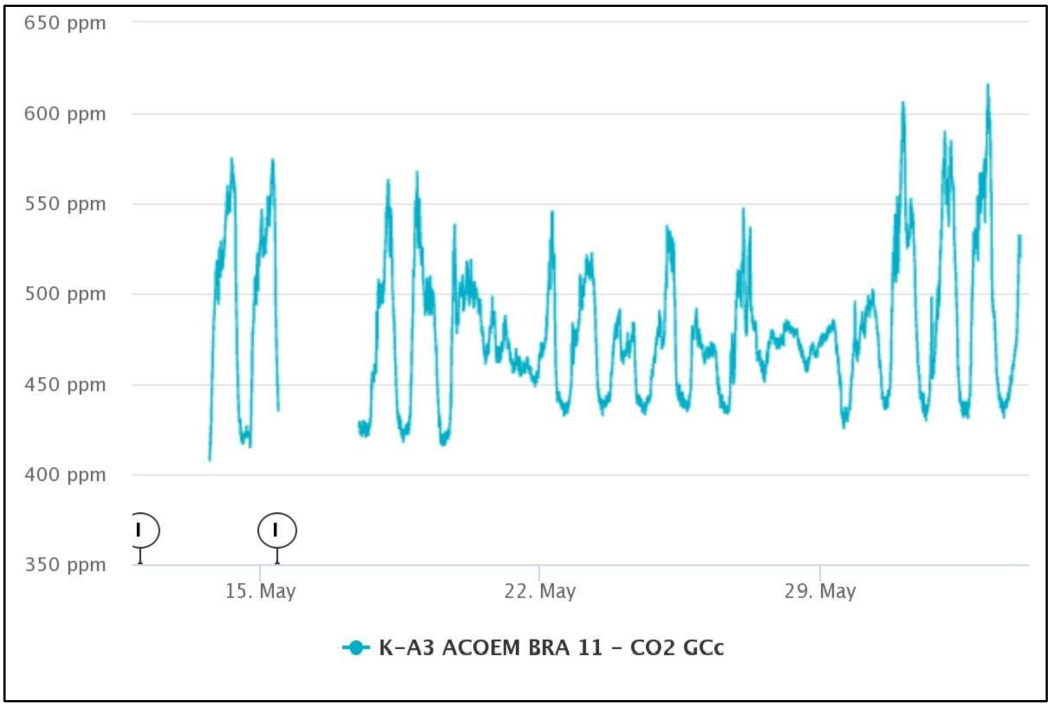


12.7.4 - Carbon Monoxide CO - 24 hour average - Pollution Rose (ppb)

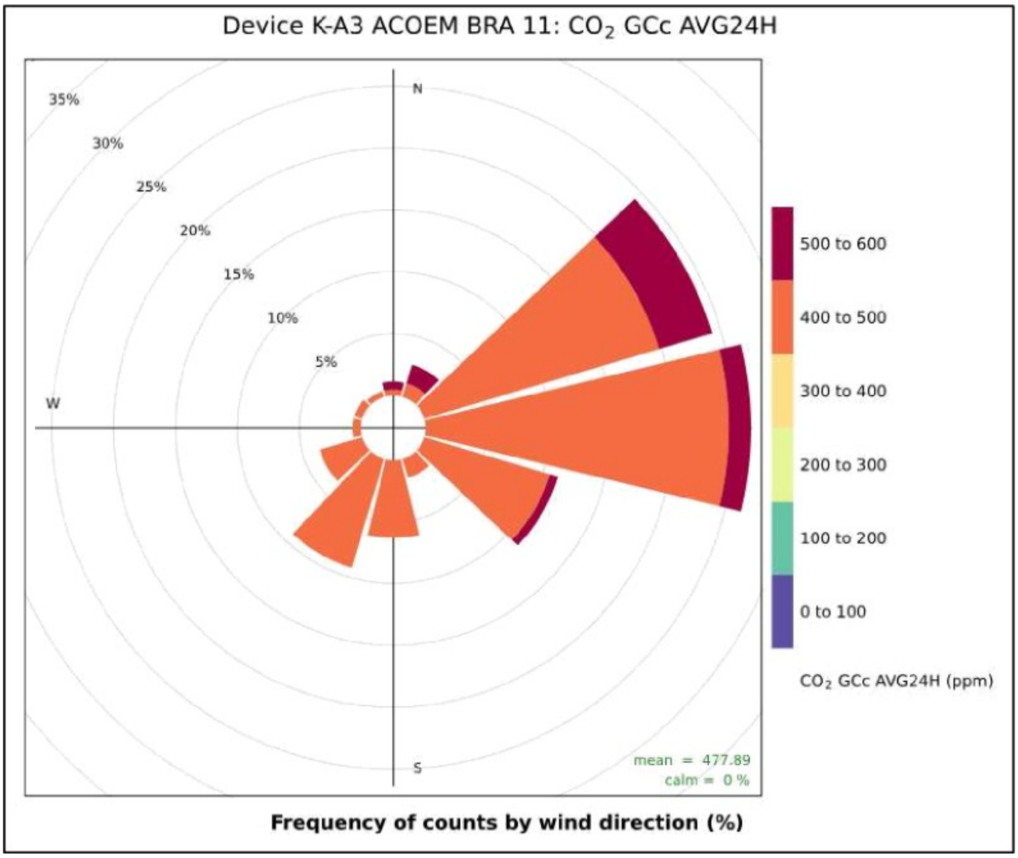
ANNEX 12.8– CO_2– Dynamic graphs and Pollution Rose.



12.8.1 – Dióxido de Carbono CO_2– Média 24 horas (ppm)

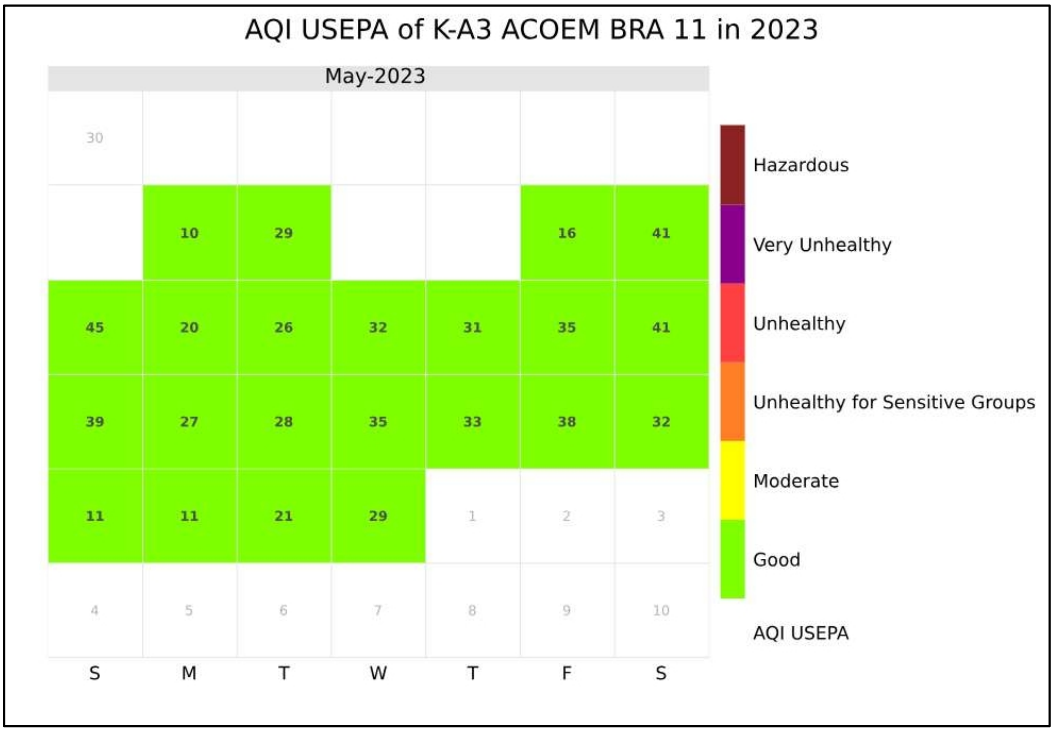


12.8.2 – Dióxido de Carbono CO_2– Amostragem Instantânea (ppm)

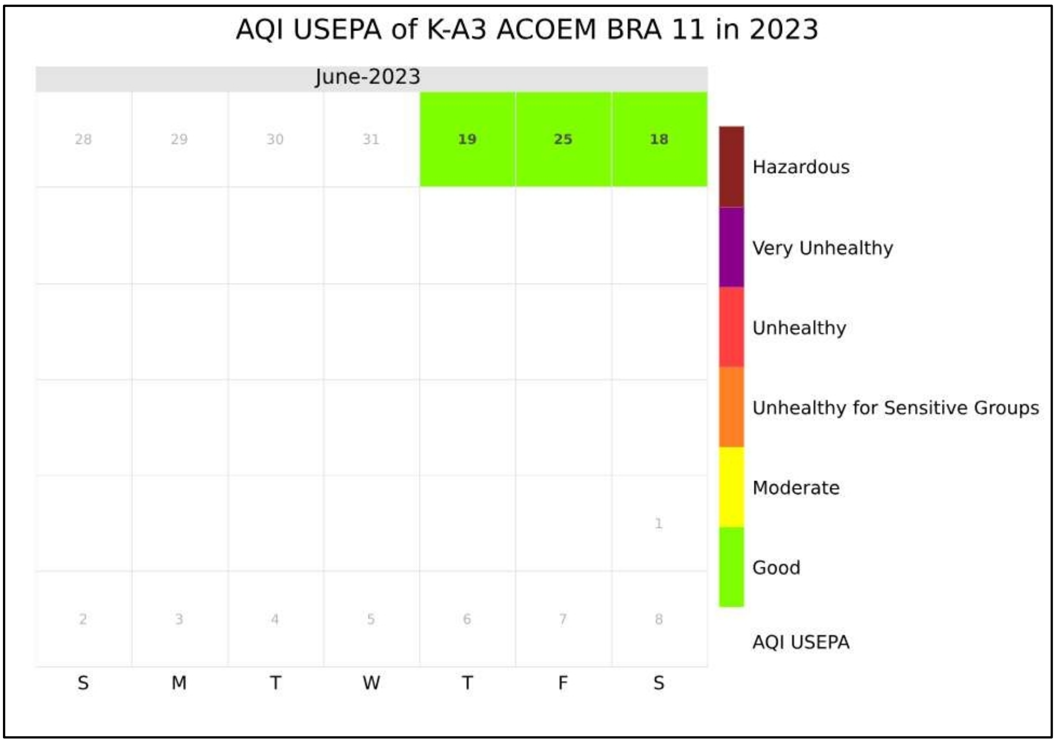


12.8.3 - COM Carbon Dioxide - 24 hour average - Pollution Rose (ppm)

ANNEX 12.9– Calendar Chart– Air Quality Index (AQI).

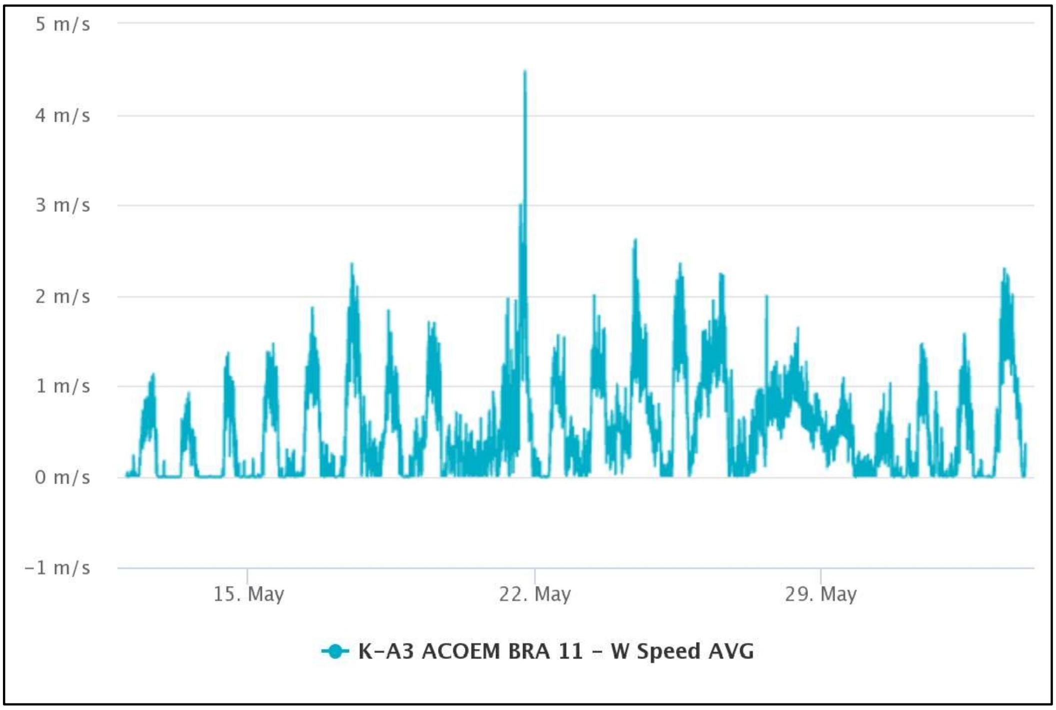


12.9.1 – Indice de Qualidade do Ar – Mês de Maio/2023 – Valores de 0 a 50 – AQI - Good

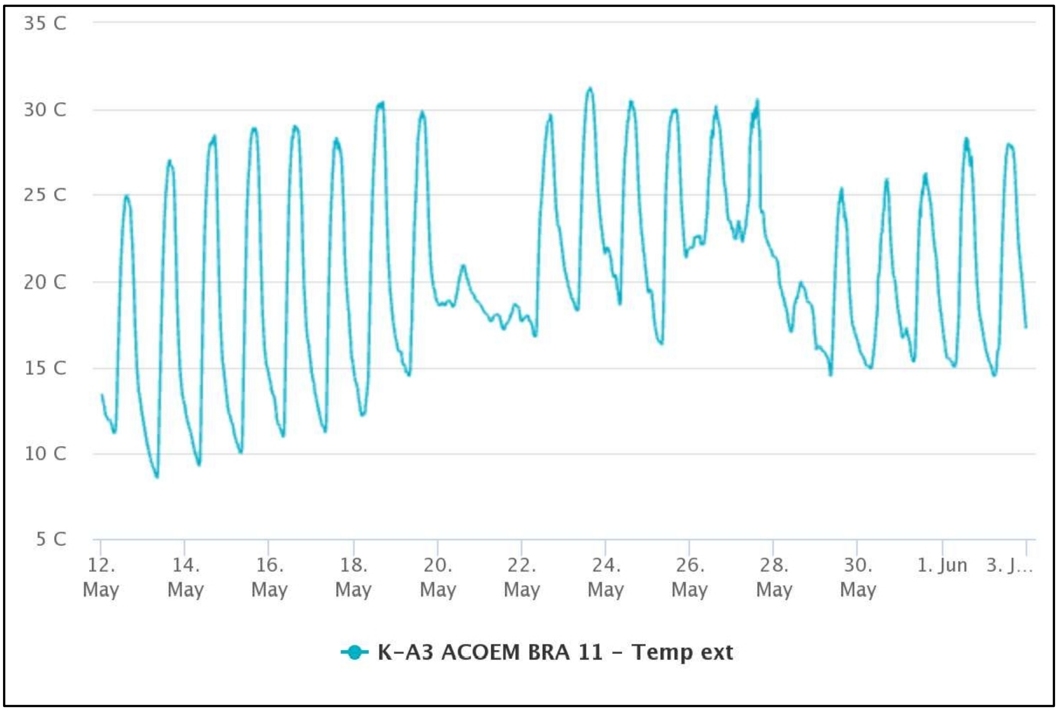


12.9.2 – Indice de Qualidade do Ar – Mês de Junho/2023 – Valores de 0 a 50 – AQI - Good

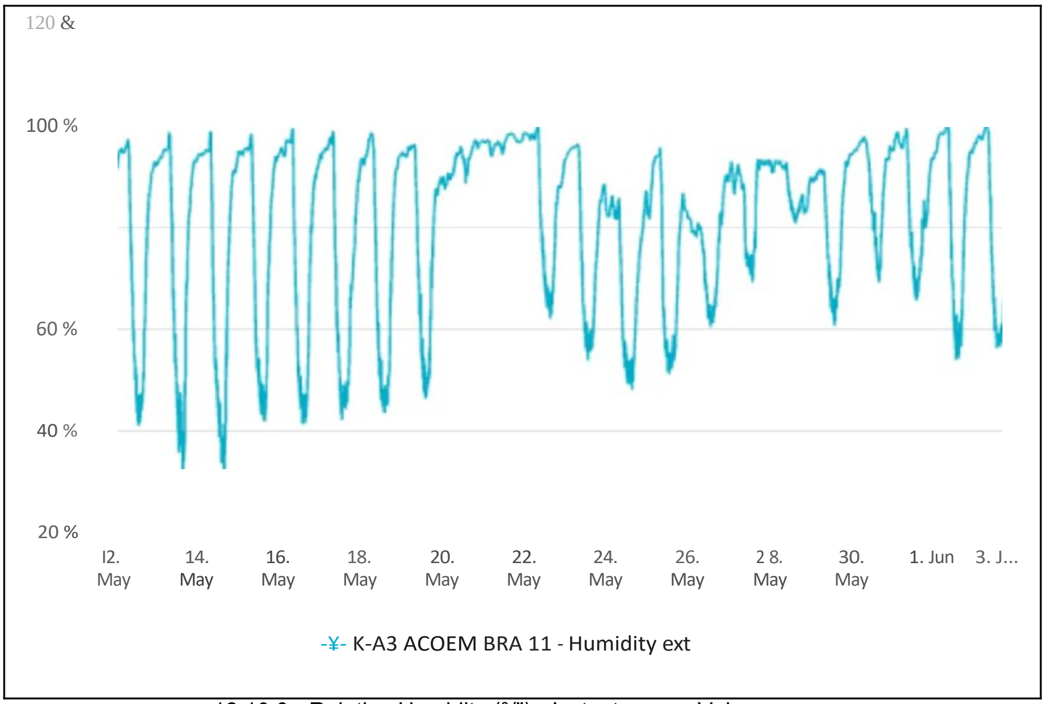
–



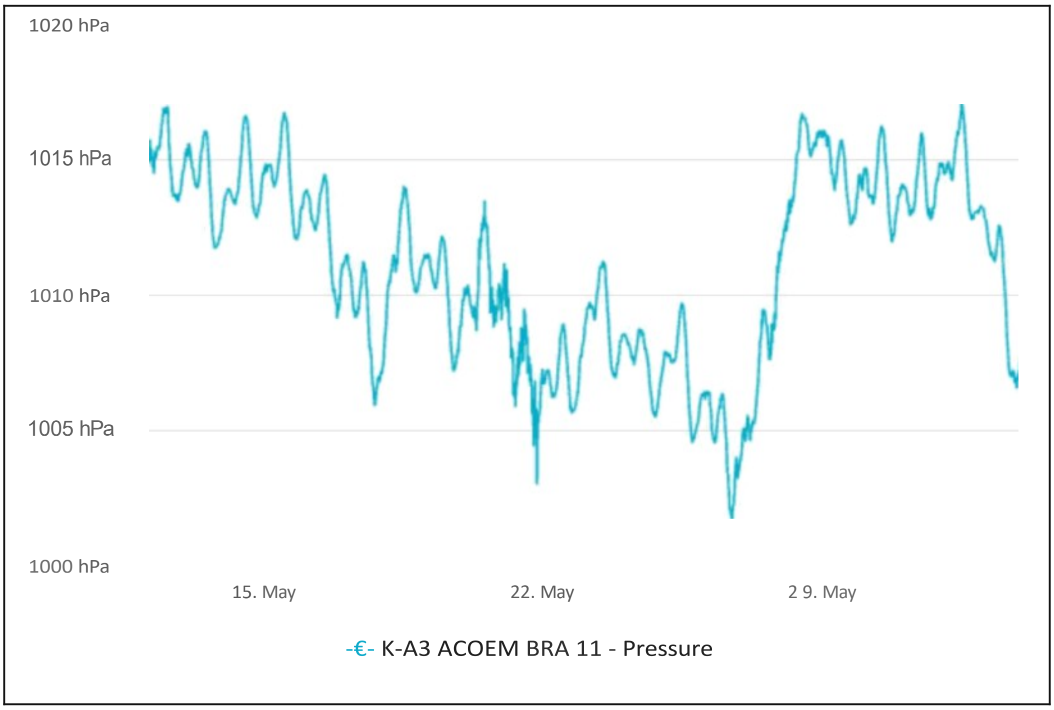
12.10.1 – Velocidade do Vento (m/s) – Valores Instantâneos



12.10.2 – Temperatura Ambiente (ºC) – Valores Instantâneos



12.10.3 - Relative Humidity (°/") - Instantaneous Values



12.10.4 - Atmospheric Pressure (hPa) - Instantaneous Values

ANNEX 12.11– Gas Sensor Calibration Certificates.

CHARACTERISATION AND CALIBRATION CERTIFICATE

KUNAK TECHNOLOGIES S.L., as manufacturer of the product, certifies that the cartridge meets the internal manufacturing quality conditions, as well as the laboratory tests and the correct calibration of the cartridges according to the QA&QC proccedings.

Cartridges are tested according to the laboratory pre-test specified in CEN/TS 17660-1:2021 "Air quality - Performance evaluation of air quality sensor systems - Part 1: Gaseous pollutants in ambient air", regarding the Response Time (t90), Limit of Detection (LOD) and Repeatability (Rep).

CERTIFIED CARTRIDGE

Cartridge type:	Carbon monoxide (CO)	**Manufacture Date:**	2021-05-07
P/N:	K-CO-A-01	**Expiry Date:**	2023-05-07
Y/N:	3021180025		

TEST 1: ENVIRONMENTAL CHARACTERISATION TEST

Environmetal characterisation test - not required for Carbon monoxide (CO) cartridges.

TEST 2: LABORATORY TEST

The Response Time, the Limit of Detection and the Repeatability of the cartridge are calculated using certified gas bottles according to the CEN/TS 17660-1:2021.

- **Response Time:** The response time of the sensor systems is estimated using t90 (the time required for the sensor system to reach 90% of the final stable value).
- **Detection limit:** Value of the measured quantity that gives the probability of falsely asserting the absence or presence of a component.
- **Repeatability:** closeness of the agreement between the results of successive measurements of the same measure and carried out under the same conditions of measurement.

Test	Cartridge S/N	Kunak requirement	TS 17660-1:2021 requirement	STATUS
Response Time	3021180025	< 30 s	< 360 s	PASS
Limit of Detection	3021180025	< 10 ppb	< 150 ppb	PASS
Repeatability	3021180025	< 20 ppb	< 50 ppb	PASS

REMARKS

The results indicated refer exclusively to the cartridge subjected to the characterisation and laboratory tests and described in this certificate.

Signature:

KUNAK TECHNOLOGIES, S.L.
C.I.F. B71110837
Parque Empresarial La Muga, 9 Plt. 4 Ofi. 1
31160 ORKOIEN (Navarra)

CHARACTERISATION AND CALIBRATION CERTIFICATE

KUNAK TECHNOLOGIES S.L., as manufacturer of the product, certifies that the cartridge meets the internal manufacturing quality conditions, as well as the laboratory tests and the correct calibration of the cartridges according to the QA&QC proccedings.

Cartridges are tested according to the laboratory pre-test specified in CEN/TS 17660-1:2021 "Air quality - Performance evaluation of air quality sensor systems - Part 1: Gaseous pollutants in ambient air", regarding the Response Time (t90), Limit of Detection (LOD) and Repeatability (Rep).

CERTIFIED CARTRIDGE

Cartridge type:	Carbon dioxide (CO_2)	**Manufacture Date:**	2023-03-22
P/N:	K-CO2-B-01	**Expiry Date:**	2025-06-21
Y/N:	3723120005		

TEST 1: ENVIRONMENTAL CHARACTERISATION TEST

Environmetal characterisation test - not required for Carbon dioxide (CO_2) cartridges.

TEST 2: LABORATORY TEST

The Response Time, the Limit of Detection and the Repeatability of the cartridge are calculated using certified gas bottles according to the CEN/TS 17660-1:2021.

- **Response Time:** The response time of the sensor systems is estimated using t90 (the time required for the sensor system to reach 90% of the final stable value).
- **Detection limit:** Value of the measured quantity that gives the probability of falsely asserting the absence or presence of a component.
- **Repeatability:** closeness of the agreement between the results of successive measurements of the same measure and carried out under the same conditions of measurement.

Test	Cartridge S/N	Kunak requirement	STATUS
Response Time	3723120005	< 180 s	PASS
Limit of Detection	3723120005	< 150 ppb	PASS
Repeatability	3723120005	< 0 ppb	PASS

REMARKS

The results indicated refer exclusively to the cartridge subjected to the characterisation and laboratory tests and described in this certificate.

Signature:

KUNAK TECHNOLOGIES, S.L.
C.I.F. B71110837
Parque Empresarial La Muga, 9 Plt. 4 Ofi. 1
31160 ORKOIEN (Navarra)

CHARACTERISATION AND CALIBRATION CERTIFICATE

KUNAK TECHNOLOGIES S.L., as manufacturer of the product, certifies that the cartridge meets the internal manufacturing quality conditions, as well as the laboratory tests and the correct calibration of the cartridges according to the QA&QC proccedings.

Cartridges are tested according to the laboratory pre-test specified in CEN/TS 17660-1:2021 "Air quality - Performance evaluation of air quality sensor systems - Part 1: Gaseous pollutants in ambient air", regarding the Response Time (t90), Limit of Detection (LOD) and Repeatability (Rep).

CERTIFIED CARTRIDGE

Cartridge type:	Nitrogen dioxide (NO2)	**Manufacture Date:**	2021-03-18
P/N:	K-NO2-A-01	**Expiry Date:**	2023-03-18
Y/N:	3221110014		

TEST 1: ENVIRONMENTAL CHARACTERISATION TEST

Typical baseline error in the whole temperature (<40ºC) and humidity range.

Test	Cartridge S/N	Test results	Kunak requirement	STATUS
Environmetal characterisation	3221110014	5.56 ppb	< 16 ppb	NO PASS

TEST 2: LABORATORY TEST

The Response Time, the Limit of Detection and the Repeatability of the cartridge are calculated using certified gas bottles according to the CEN/TS 17660-1:2021.

- **Response Time:** The response time of the sensor systems is estimated using t90 (the time required for the sensor system to reach 90% of the final stable value).
- **Detection limit:** Value of the measured quantity that gives the probability of falsely asserting the absence or presence of a component.
- **Repeatability:** closeness of the agreement between the results of successive measurements of the same measure and carried out under the same conditions of measurement.

Test	Cartridge S/N	Kunak requirement	TS 17660-1:2021 requirement	STATUS
Response Time	3221110014	< 120 s	< 360 s	PASS
Limit of Detection	3221110014	< 3 ppb	< 10 ppb	PASS
Repeatability	3221110014	< 4 ppb	< 4 ppb	PASS

REMARKS

The results indicated refer exclusively to the cartridge subjected to the characterisation and laboratory tests and described in this certificate.

Signature:

KUNAK TECHNOLOGIES, S.L.
C.I.F. B71110837
Parque Empresarial La Muga, 9 Plt. 4 Ofi. 1
31160 ORKOIEN (Navarra)

CHARACTERISATION AND CALIBRATION CERTIFICATE

KUNAK TECHNOLOGIES S.L., as manufacturer of the product, certifies that the cartridge meets the internal manufacturing quality conditions, as well as the laboratory tests and the correct calibration of the cartridges according to the QA&QC proccedings.

Cartridges are tested according to the laboratory pre-test specified in CEN/TS 17660-1:2021 "Air quality - Performance evaluation of air quality sensor systems - Part 1: Gaseous pollutants in ambient air", regarding the Response Time (t90), Limit of Detection (LOD) and Repeatability (Rep).

CERTIFIED CARTRIDGE

Cartridge type:	Ozone (O3)	**Manufacture Date:**	2021-05-05
P/N:	K-O3-A-01	**Expiry Date:**	2023-05-05
Y/N:	3321180032		

TEST 1: ENVIRONMENTAL CHARACTERISATION TEST

Typical baseline error in the whole temperature (<40ºC) and humidity range.

Test	Cartridge S/N	Kunak requirement	STATUS
Environmetal characterisation	3321180032	< 7.5 ppb	NO PASS

TEST 2: LABORATORY TEST

The Response Time, the Limit of Detection and the Repeatability of the cartridge are calculated using certified gas bottles according to the CEN/TS 17660-1:2021.

- **Response Time:** The response time of the sensor systems is estimated using t90 (the time required for the sensor system to reach 90% of the final stable value).
- **Detection limit:** Value of the measured quantity that gives the probability of falsely asserting the absence or presence of a component.
- **Repeatability:** closeness of the agreement between the results of successive measurements of the same measure and carried out under the same conditions of measurement.

Test	Cartridge S/N	Kunak requirement	TS 17660-1:2021 requirement	STATUS
Response Time	3321180032	< 120 s	< 360 s	PASS
Limit of Detection	3321180032	< 3 ppb	< 10 ppb	PASS
Repeatability	3321180032	< 4 ppb	< 4 ppb	PASS

REMARKS

The results indicated refer exclusively to the cartridge subjected to the characterisation and laboratory tests and described in this certificate.

Signature:

KUNAK TECHNOLOGIES, S.L.
C.I.F. B71110837
Parque Empresarial La Muga, 9 Plt. 4 Ofi. 1
31160 ORKOIEN (Navarra)

CHARACTERISATION AND CALIBRATION CERTIFICATE

KUNAK TECHNOLOGIES S.L., as manufacturer of the product, certifies that the cartridge meets the internal manufacturing quality conditions, as well as the laboratory tests and the correct calibration of the cartridges according to the QA&QC proccedings.

Cartridges are tested according to the laboratory pre-test specified in CEN/TS 17660-1:2021 "Air quality - Performance evaluation of air quality sensor systems - Part 1: Gaseous pollutants in ambient air", regarding the Response Time (t90), Limit of Detection (LOD) and Repeatability (Rep).

CERTIFIED CARTRIDGE

Cartridge type:	Sulphur dioxide (SO2)	**Manufacture Date:**	2021-05-05
P/N:	K-SO2-A-01	**Expiry Date:**	2023-05-05
Y/N:	3521180016		

TEST 1: ENVIRONMENTAL CHARACTERISATION TEST

Typical baseline error in the whole temperature (<40ºC) and humidity range.

Test	Cartridge S/N	Kunak requirement	STATUS
Environmetal characterisation	3521180016	< 15 ppb	NO PASS

TEST 2: LABORATORY TEST

The Response Time, the Limit of Detection and the Repeatability of the cartridge are calculated using certified gas bottles according to the CEN/TS 17660-1:2021.

- **Response Time:** The response time of the sensor systems is estimated using t90 (the time required for the sensor system to reach 90% of the final stable value).
- **Detection limit:** Value of the measured quantity that gives the probability of falsely asserting the absence or presence of a component.
- **Repeatability:** closeness of the agreement between the results of successive measurements of the same measure and carried out under the same conditions of measurement.

Test	Cartridge S/N	Kunak requirement	TS 17660-1:2021 requirement	STATUS
Response Time	3521180016	< 120 s	< 360 s	PASS
Limit of Detection	3521180016	< 3 ppb	< 10 ppb	PASS
Repeatability	3521180016	< 4 ppb	< 4 ppb	PASS

REMARKS

The results indicated refer exclusively to the cartridge subjected to the characterisation and laboratory tests and described in this certificate.

Signature:

KUNAK TECHNOLOGIES, S.L.
C.I.F. B71110837
Parque Empresarial La Muga, 9 Plt. 4 Ofi. 1
31160 ORKOIEN (Navarra)

Annex 5 – Sound Pressure Level Monitoring Report (Baseline)

SOUND PRESSURE LEVEL MONITORING RESULTS REPORT

PROJECT:
PLANTA INDUSTRIAL ATOME S.A.

CUSTOMER:	ATOME S.A.
DISTRICT:	VILLETA
DEPARTAMENTO:	CENTRAL
CONSULTANT:	TECNOAMBIENTAL S.R.L
CTCA CODE:	E-133

October 2023

1. INTRODUCTION

ATOME Paraguay S.A., hereinafter *"The Company"*, is developing an industrial project to be installed on a 30-hectare property in the district of Villeta. The industry will be the first dedicated to the production of hydrogen, ammonia and green fertilizers.

The company contracted Tecnoambiental S.R.L. to carry out the environmental noise survey with the aim of collecting data on current noise levels, evaluating and comparing with the maximum permissible limits established in national legislation and the General Guidelines on the Environment, Health and Safety (MASS) of the International Finance Corporation (IFC)/World Bank.

The survey was carried out on September 30 and October 9, 2023, in places defined jointly with *The Company*. These were established within the property; specifically considering the location of future major sources of noise emission, and off-property; taking into account the presence of critical receptors.

The regulatory framework, methodology and results of the noise measurement campaign are described below.

2. REGULATORY FRAMEWORK

2.1 National

2.1.1 Law No. 6390/20 Regulating Noise Emission

The purpose of this law is to regulate the emission of noise capable of affecting the well-being or damaging the health of people or living beings, in order to ensure the due protection of the population, the environment and property affected by exposure to noise.

According to Article 4, the municipalities shall be the authority for the application of this Law. They are responsible for exercising the duties and powers established in this Law.

Among the main duties of municipalities are:

1. Determine the standards, categories and permitted emission sources, which must be established according to the characteristics of the noise emitter and the receiving medium.

2. Establish the permitted and prohibited noise levels by regulation.

3. Establish reference techniques for sampling, measurements, analysis, evaluation of noise pollution, and for the verification and calibration of measuring instruments.

The city of Villeta does not have up-to-date regulations to the aforementioned Law, therefore, the average values specified in Law No. 1100/97 "On the Prevention of Noise Pollution" are used as a reference.

2.1.2 Law No. 1100/97 on the Prevention of Noise Pollution

The purpose of this law is to prevent noise pollution on public roads, squares, parks, promenades, performance halls, meeting centres, sports and social clubs and in all public and private activities that produce noise pollution.

According to Article No. 9, noise and annoying sounds are considered to be those that exceed the average levels specified in Table 1.

Table 1. Maximum permissible sound levels per area

Area	Night 8:00 p.m. to 7:00 a.m.	Day 07:00 to 20:00	Day (Occasional Peak) 07:00 to 12:00 14:00 to 19:00
	Measured in decibels "A"		
Residential areas for specific use, public spaces: recreational areas, parks, squares and public roads.	45	60	80
Mixed Areas, Transition Zones, Urban Centres, Specific Programmes, Service Areas and Public Buildings	55	70	85
Industrial area	60	75	90

Source: Paraguay (1997).

To compare the Leq results in dBA obtained with Law No. 1100/97, the maximum permitted values defined for the Industrial Area, highlighted in gray, were used.

Taking into account the presence of a dwelling where Point 3 of measurement was located, for the contrast of the Leq results in dBA at this point, the maximum permitted values defined for the Area corresponding to residential areas of specific use, public spaces: recreational areas, parks, squares and public roads highlighted in light blue were used.

2.1.3 Ordinance No. 25/2017 amending and updating Ordinance No. 2/94 regulating the advertising and noise nuisance system within the district of Villeta

In the district of Villeta, Law No. 1100/97 is regulated by Ordinance No. 25/2017, which amends and updates Ordinance No. 2/94, which regulates the system of advertising and nuisance noise within the district of Villeta, in accordance with the provisions of this Law.

Article 1 of this Ordinance establishes the prohibition throughout the district of Villeta of causing annoying sounds, as well as vibrations when, due to time, place or intensity, they affect the tranquility, rest, health and material goods of the population.

As for industrial installations that, located in residential areas, that make hammers or produce annoying noises, will operate within the hours of 06:00 to 12:00 and from 14:00 to 20:00 hours. Likewise, they must adopt the required devices to reduce the noise produced.

2.2 International

2.2.1 IFC/World Bank General Guidelines on Environment, Health and Safety

The IFC/World Bank MASS Guides are technical reference documents containing general and specific examples of International Good Practice for Industry. These guides contain the levels and performance indicators that can generally be achieved in new installations, with existing technology and at reasonable costs.

The guidelines state that noise impacts may not exceed the levels set out in the following Table of Noise Level Guidelines.

Table 2. Noise Level Guides

Receptor	**One hour LAeq (dBA)**	
	Day 07:00 – 22:00	**Night 22:00 – 07:00**
Residential, Institutional, Educational	55	45
Industrial, Commercial	70	70

Source: IFC (2007).

It should be noted that the IFC also states that the maximum increase in background noise levels can be up to 3 dB at the nearest receiver.

To contrast the Leq results in dBA obtained with the General Guidelines on Environment, Health and Safety of the International Finance Corporation, the noise level guide values defined for the Industrial Receiver highlighted in gray were used.

Taking into account the presence of a house where Point 3 of measurement was located, for the contrast of the Leq results in dBA at this point, the noise level guide values defined for the Residential, Institutional, Educational Receiver highlighted in light blue were used.

Noise monitoring shall be carried out for the purpose of establishing existing ambient noise levels in the area of proposed and existing installations, or for the purpose of checking noise levels in the operational phase.

3. MATERIALS AND METHODS

3.1 Measuring Points

The selection of the measurement points was based on the methodology proposed by Segués (2008), of directed selection of measurement points based on land uses and noise sources, which consists of previously analyzing the dynamics of the activity, land uses and establishing a zoning of the study area. On the other hand, the main sources of noise, roads, industries, sensitive areas, etc., must be analyzed.

This methodology is in accordance with the recommended method for the measurement of environmental noise in the ISO 1996-2:2017 Standard, which measures the equivalent continuous level in frequency weighting A dB(A), where they also indicate that the selection of points should be established according to the generating source.

Considering the above, Table 3 mentions the four (4) selected measurement points and their description.

Table 3. Description of Measurement Points

Point N°	Geographic Coordinates	Description of Measurement Points
1 - Main access to the property	25°42'33.6"S 57°41'56.6"W	Point of circulation of mobile emission sources, such as machinery and heavy trucks and other types of vehicles of different sizes linked to the construction and operation/maintenance stage of the project. In addition, it is a strategic point for measuring noise levels, due to its proximity to the Villeta-Alberdi Route.
2 - ATOME Property Boundary – Near Neighbor's Barn	25°42'36.7"S 57°42'09.6"W	Area close to the dwelling of the neighbors of the adjoining property, the main critical receivers of the noise levels that the industry would generate, due to the proximity of the installation of certain equipment and service areas, as well as continuous work during the construction and operation/maintenance stage, in general.
3 – Main access to the Neighbor's home	25°42'37.9"S 57°42'06.6"W	Registration point located at the main access to the neighbors' homes, they would be direct receivers of the noise levels that could occur in the different stages of the industry, which could affect their health and alter their quality of life.
4 – Future area of fixed noise sources	25°42'31.8"S 57°42'06.8"W	It corresponds to a sector of industry where emission sources such as machinery and equipment of continuous operation (mainly compressors) would be found, which could generate high noise levels, which could affect occupational and housing levels.

Figure 1 shows the location of each of the 4 selected points.

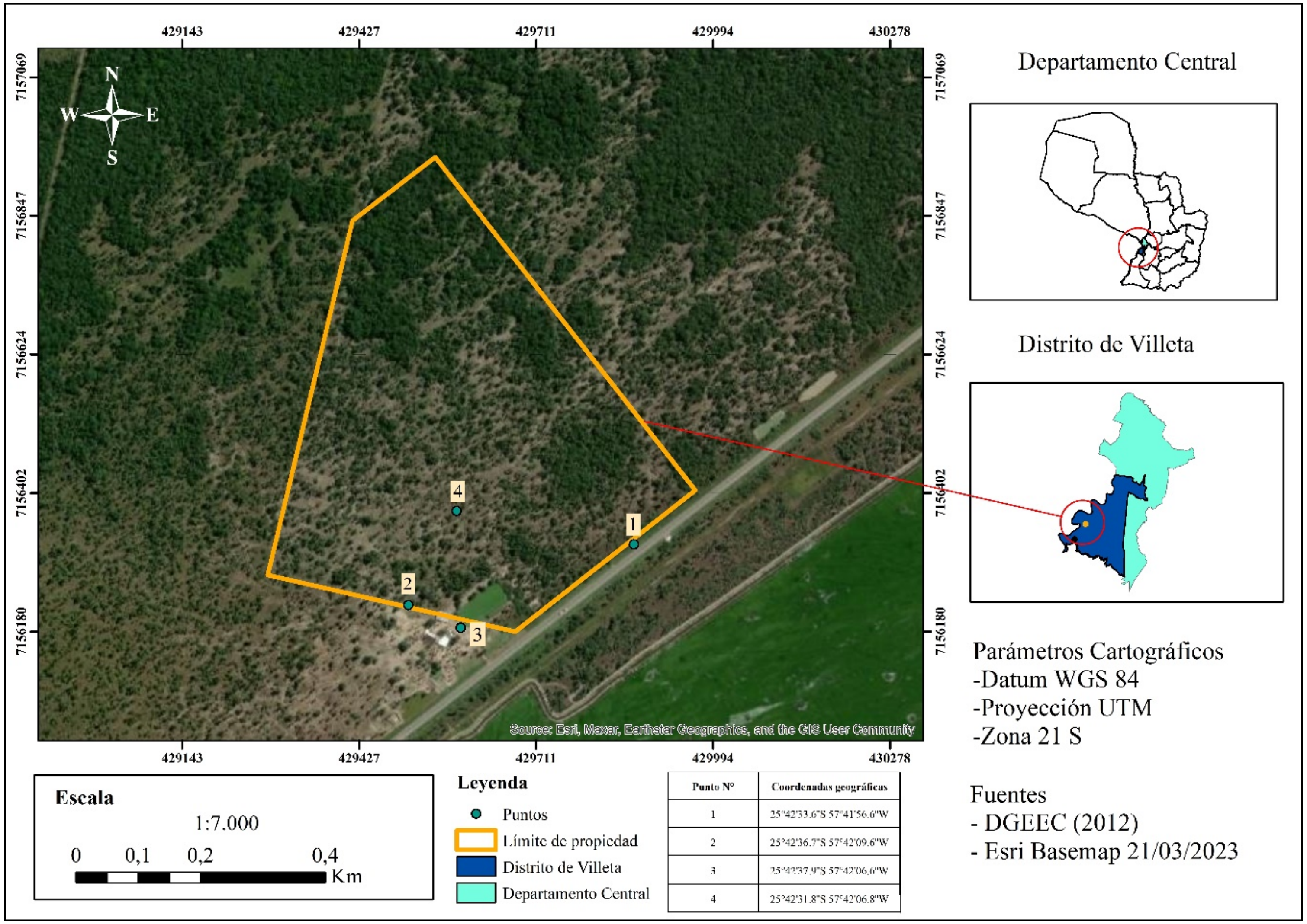


Figura 1. Localización de los puntos de medición de niveles sonoros.

3.2 Equipment

Sound level monitoring was performed with two Class 2 sound level meters that comply with IEC 61672-1 and IEC PUB 651 standards, the **PCE-322A sound level meter** and the **Minipa MSL-1355B sound level meter,** respectively**.**

Both are high-performance instruments, suitable for measuring sounds in the industrial, health, safety and environmental sectors. Both sound level meters comply with the provisions of the International Finance Corporation's General Guidelines on Environment, Health and Safety (2007): they are Type 2, frequency weighting A was used and comply with the applicable IEC standards.

The technical specifications of sound level meters are presented in Annex 8.1. Likewise, Annex 8.3 and 8.4 include the calibration certificates issued by LABSOL S.A., a calibration service provider company accredited by the National Accreditation Body (ONA), as a calibration laboratory, in accordance with the NP-ISO/IEC 17025:2018 Standard, equivalent to the ISO/IEC 17025:2017 Standard "General requirements for the competence of testing and calibration laboratories" and the requirements established in the regulations, ONA criteria and policies applicable to calibration laboratories in their current version.

3.3 Data collection

Data collection was carried out for 20 continuous hours at the 4 measurement points. The sound level meters were programmed to measure with frequency weighting A, in a range of 30 to 130 dB. The sound level meters were placed on a tripod to be placed at a distance of approximately 1.5 meters above the ground, and it was also taken into account that they are no closer than 3 meters from any reflective surface (walls, structures, obstacles), as specified in the IFC/World Bank MASS Guidelines.

According to the IFC General Guidelines on Environment, Health and Safety (2007), the usual monitoring periods should be sufficient for the statistical study and can last 48 hours with the use of noise monitoring devices that should have the ability to record data continuously during this period of time. or hourly or more frequently as deemed appropriate (or otherwise covering periods of time within multiple days, including weekdays on weekdays or over the weekend).

Due to the capacity of the Minipa MSL-1355B Sound Level Meter **Datalogger** and in order to have the largest number of records during the total measurement time, the equipment was configured in a measurement time interval of 1 data every 16 seconds, thus obtaining 4,502 records in 20 hours of measurement. As for the **PCE-322A sound level meter,** whose *Datalogger* has a larger data storage memory, yielding 1 data per second, 72,000 records were obtained in the 20 hours of measurement.

At the same time, the atmospheric variables in the weather forecast of the Directorate of Meteorology and Hydrology (DMH) were verified daily, considering the impact that climatic conditions may have on the sound measurements. A cap was used to protect the equipment from the wind and on rainy days the measurements were suspended and re-planned.

Table 4 below shows the details of the measurement schedules at each of the measurement points.

Table 4. Measurement schedules at each of the registration points.

Point N°	Measurement Start Time	End Time Measurements	Total Measurement Time
1	04:31:00	00:31:16	20 hours, 16 seconds
2	05:35:00	01:35:16	20 hours, 16 seconds
3	05:33:12	01:33:28	20 hours, 16 seconds
4	05:51:00	01:51:16	20 hours, 16 seconds

3.4 Data Processing and Analysis

3.4.1 Data Pre-Processing

Considering the differences in measurement time interval of each sound level meter, the records were pre-processed in order to standardize the amount of data between the two devices for analysis in the 20 hours of measurement at each of the 4 points. To this end, the following was done:

1) First, the data from each sound level meter were pooled every 1 hour, for the Minipa sound level meter 225 records were obtained, and for the PCE sound level meter 3,600 records were obtained.

2) Next, a simple random sampling was carried out by means of Microsoft Excel, which consists of a technique in which all the elements of a population or universe can be selected for the sample of a research. This selection process is carried out randomly or randomly, without the intervention of the researcher. This was done to randomly collect 225 recordings from the 3,600 PCE sound level meter records every hour, and thus have the same amount of data between the two sound level meters.

3.4.1 Data Processing

The data obtained by the sound level meters were processed in Microsoft Excel in order to obtain a spreadsheet with the means for each point. Due to the logarithmic nature of the sound level values, the equivalent continuous sound level (Leq) was calculated using the following formula:

Leq = 10log((Σti·10^Li/10)/T) dBA

Where:

T: This is the total duration of the measurement
Ti: is the instantaneous observation time per second
Li: Instantaneous Sound Pressure

It is important to determine the Leq value, as it represents the constant total exposure to sound levels over a period of time of interest.

The results of the Leq value measurements were calculated by specifying the frequency weight that was used (dBA), and the desired measurement time duration. For this study, it was defined to represent the Leq data every 1 hour **(LAeq1hour),** thus having 20 data for the total measurement time of 20 hours at each point.

The results were analyzed and presented in figures and tables, in such a way that the sound levels in dBA and their behavior are visualized. In this way, the temporal variability for each of the selected points is made visible.

The figures show the data on instantaneous sound levels in dB and the cumulative Leq levels in dBA, with the corresponding contrast with Law No. 1100/97 on the Prevention of Noise Pollution and the IFC/World Bank EHS Guidelines.

A sound map is also presented to achieve a graphical presentation of the behavior of sound levels in the study area.

4. RESULTS

4.1 Weather conditions

The climatic variables were obtained from the weather forecast of the Directorate of Meteorology and Hydrology (DMH). The following conditions were considered to develop the measurements:

1. Precipitation: dry weather.
2. Temperature: range above -10 °C and below 50°C.
3. Relative humidity: up to 90%.
4. Wind speed: up to 5 m/s (18 km/h). At higher wind speeds, the turbulent noise caused by the wind can mask the source of noise to be measured. However, measurements with wind speeds of up to 10 m/s (36 km/h) can be accepted. In general, wind noise peaks should be at least 10 dB below the noise source to be measured.

Table 5 shows the climatic conditions recorded every 2 hours in Villeta during the measurement days.

Table 5. Climatic conditions recorded in the city of Villeta during the measurement days.

Day	Hour	Atmospheric Variables				
		Temperature °C	*Relative humidity %*	*Velocity of the wind km/h*	*Wind Direction N, S, E, O*	*Rainfall mm*
30/09/2023	05:00	17	77	14	Sur Sur Oeste	-
	07:00	19	77	11	Sur Sur Oeste	-
	09:00	22	73	7	On	-
	11:00	25	69	5	On	-
	13:00	26	63	11	South West	-
	15:00	26	55	17	Sur Sur Oeste	-
	17:00	24	56	19	South West	-
	19:00	23	56	19	South West	-
	21:00	21	54	20	On	-
	23:00	20	63	18	On	-
	01:00	18	60	18	On	-
09/10/2023	05:00	17	85	3	South East	-
	07:00	18	80	3	South East	-
	09:00	22	68	4	On	-
	11:00	26	41	7	On	-
	13:00	29	31	9	On	-
	15:00	28	35	9	South East	-
	17:00	26	41	11	On	-
	19:00	26	41	13	South West	-
	21:00	22	40	13	On	-
	23:00	19	38	11	On	-
	01:00	18	38	11	On	-

Source: Directorate of Meteorology and Hydrology, DMH (daytime forecast).

The climatic conditions presented in the two days of measurement were suitable for recording the sound levels.

4.2 Results of LAeq1hour (dBA) sound levels in Point 1

Table 6 shows the results of the sound levels in LAeq1hour in dBA corresponding to Point 1 of measurement and their contrast with Law No. 1100/97 on the Prevention of Noise Pollution and the IFC MASS Guidelines.

The total compliance of the results obtained with the provisions of the IFC Guidelines is highlighted. With regard to compliance with Law No. 1100/97, it was also possible to verify full compliance with the schedule from 07:00 to 20:00; However, from 20:00 to 07:00 the levels were higher than what is allowed by law, except for the first time of measurement (04:31:00).

Table 6. Compliance with national and international regulations of the results of the sound levels LAeq1hour (dBA) in Point 1

Point	Timetable	Cumulative sound level LAeq1hour (dBA)	Compliance			
			Ley N° 1100/97		CFI Guides	
			07:00 to 20:00	8:00 p.m. to 7:00 a.m.	07:00 to 22:00	10:00 p.m. to 7:00 a.m.
			75 dBA	60 dBA	70 dBA	
1 – Main Access to the Property	04:31:00	57,1*		✓	✓	
	05:31:00	64,44431207		×	✓	
	06:31:00	63,0156269		×	✓	
	07:31:00	61,34709751	✓		✓	
	08:31:00	61,32018686	✓		✓	
	09:31:00	60,75769404	✓		✓	
	10:31:00	64,25489113	✓		✓	
	11:31:00	63,80845616	✓		✓	
	12:31:00	64,83809346	✓		✓	
	13:31:00	64,45128289	✓		✓	
	14:31:00	64,61098871	✓		✓	
	15:31:00	64,56975525	✓		✓	
	16:31:00	65,2993824	✓		✓	
	17:31:00	65,14630637	✓		✓	
	18:31:00	65,06028275	✓		✓	
	19:31:00	65,37374355*	✓		✓	
	20:31:00	65,33555629		×	✓	
	21:31:00	65,11980296		×	✓	
	22:31:00	64,93759659		×	✓	
	23:31:00	64,8339658		×	✓	
	00:31:16	64,71544284		×	✓	

*The maximum recorded value of LAeq1hour was 65.37 dBA; while the minimum value of LAeq1hour was 57.1 dBA.

4.2.1 Behaviour of sound levels in Point 1

Figure 2 shows the behavior of the instantaneous sound levels per second in dB recorded during the total measurement time, as well as the results obtained from LAeq1hour in dBA. In addition, the figure shows the lines that represent the maximum permitted values established in Law No. 1100/97 on the Prevention of Noise Pollution (red line) and the IFC's General Guidelines on the Environment, Health and Safety (orange line).

The highest value of instantaneous sound levels was 89.4 dB; It was produced and recorded at the exact moment that one of the tires of a medium-sized cargo truck that was traveling along the Villeta-Alberdi Route exploded. It is important to remember that Point 1 of measurement was located at the future main access of the Industrial Plant, therefore, it was very close to the aforementioned Route. This incident occurred approximately 30 meters away from where the sound level meter was located.

The other instantaneous sound levels recorded, which are in a range between 70 and 85 dB, were caused by the different mobile sources, mainly large trucks that traveled along the Route at high speeds. The circulation of heavy trucks was more frequent at night and early in the morning.

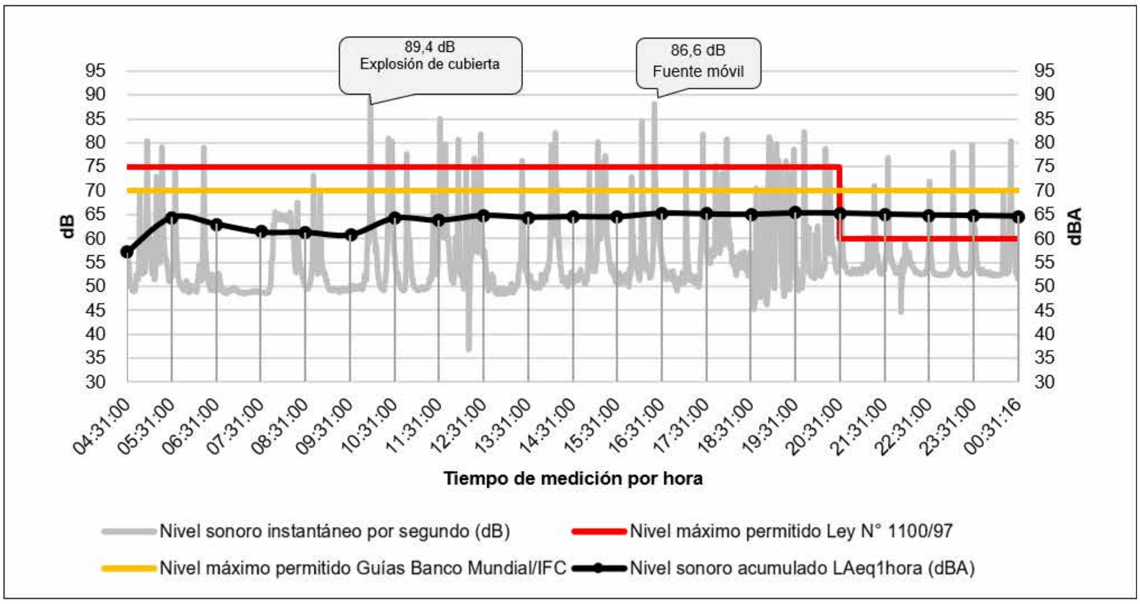


Figure 2. Behaviour of LAeq1hour (dBA) sound levels and their contrast with national and international standards in Point 1

The minimum instantaneous sound level recorded was 36.8 dB; and the average was 55.1 dB; which would be practically the levels that were maintained in the vicinity of the measurement point (in the absence of any external source, for example: mobile sources) produced by different types of insects, amphibians, birds.

LAeq1hour results remained in a range of 57.1 and 65.3 dBA during the 20 hours of measurement.

4.3 Results of sound levels LAeq1hour (dBA) in Point 2

Table 7 shows the results of the sound levels in LAeq1hour in dBA corresponding to Point 2 of measurement and their contrast with Law No. 1100/97 on the Prevention of Noise Pollution and the international requirements established in the IFC's MASS Guidelines.

The results obtained have been fully complied with in accordance with the provisions of the IFC's MASS Guidelines and Law No. 1100/97 on the prevention of noise pollution.

Table 7. Compliance with national and international regulations of the results of the sound levels LAeq1hour (dBA) in Point 2

Point	Timetable	Cumulative sound level LAeq1hour (dBA)	Compliance			
			Ley N° 1100/97		CFI Guides	
			07:00 to 20:00	8:00 p.m. to 7:00 a.m.	07:00 to 22:00	10:00 p.m. to 7:00 a.m.
			75 dBA	60 dBA	70 dBA	
2 – ATOME Property Boundary – Near Neighbor's Barn	05:35:00	58,2		✓	✓	
	06:35:00	58,24211962		✓	✓	
	07:35:00	59,62836528	✓		✓	
	08:35:00	59,95574047*	✓		✓	
	09:35:00	58,74830527	✓		✓	
	10:35:00	58,09150913	✓		✓	
	11:35:00	57,32191866	✓		✓	
	12:35:00	57,22802704	✓		✓	
	13:35:00	57,78400861	✓		✓	
	14:35:00	57,80089311	✓		✓	
	15:35:00	57,76402453	✓		✓	
	16:35:00	58,11401744	✓		✓	
	17:35:00	57,838031	✓		✓	
	18:35:00	57,60459953	✓		✓	
	19:35:00	57,64053894	✓		✓	
	20:35:00	57,36483823		✓	✓	
	21:35:00	57,18615704		✓	✓	
	22:35:00	57,15483786		✓	✓	
	23:35:00	56,92197917		✓	✓	
	00:35:00	56,69516653		✓	✓	
	01:35:16	56,62094827*		✓	✓	

*The maximum recorded value of LAeq1hour was 59.9 dBA; while the minimum value of LAeq1hour was 56.62 dBA.

4.3.1 Behaviour of sound levels in Point 2

Figure 3 shows the behavior of the instantaneous sound levels per second in dB recorded during the total measurement time, as well as the results obtained from LAeq1hour in dBA. In addition, the figure shows the lines that represent the maximum permitted values established in Law No. 1100/97 on the Prevention of Noise Pollution (red line) and the IFC MASS Guidelines (orange line).

Point 2 of measurement was located on Atome's property but close to the home of the neighbors of the adjoining property, whose activity is characterized by the breeding of various types of farm animals. It is important to remember the dynamics of the environment of the measurement point, since the highest value of instantaneous sound levels recorded was 83.6 dB; that they occurred at two times of the day, one of them in the early hours of the morning (07:17:08) which coincides exactly with the time when the horses were taken to graze, and the other in the afternoon (16:28:20) when the horses returned to the barn; The coming and going of the animals involved their passage through the vicinity of the measuring point (neighing and galloping), generating the aforementioned sound levels.

In addition, other values that exceed 70 dB could be attributed to the other animals on the farm, mainly birds such as chickens, ducks, turkeys, geese, roosters, etc., which at times also moved in the vicinity of the measurement point and that with their songs and clucks became sources of sound levels.

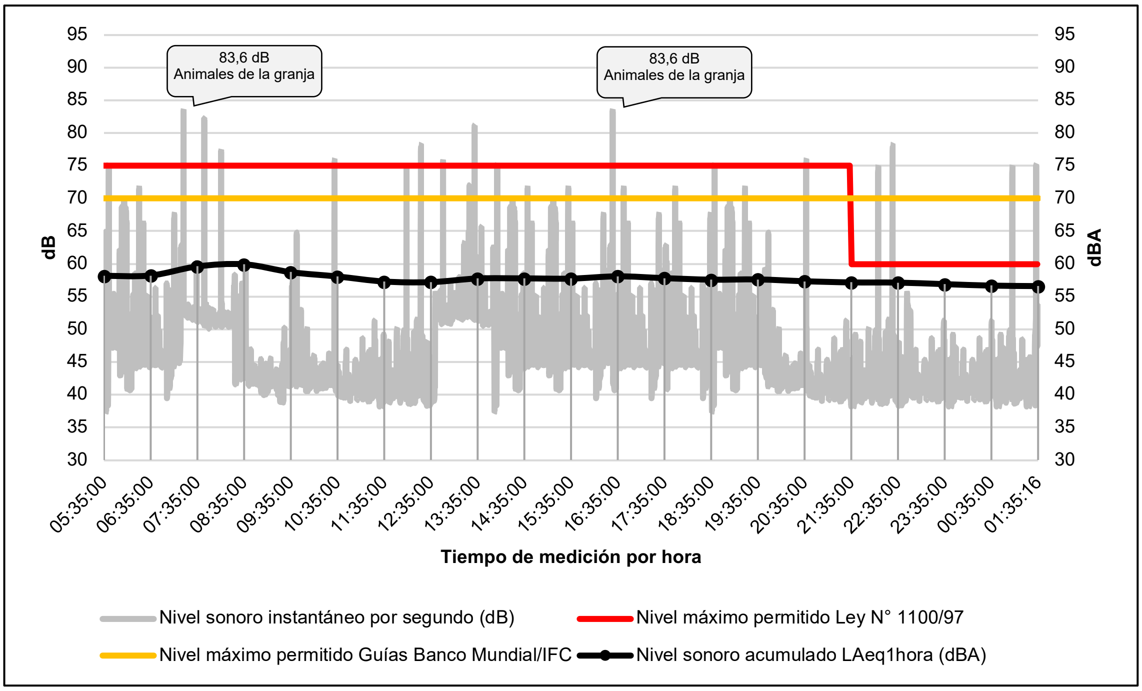


Figure 3. Behaviour of $LAeq_{1hora}$ (dBA) and its contrast with national and international regulations in Point 2

At night and early in the morning, when the farm animals were already sheltering in the barn or in the pens, the canines with their barking became sources of sound levels.

The minimum instantaneous sound level recorded was 37.4 dB; and the average yielded a value of 45.6 dB. In addition, the sounds generated by different types of insects, amphibians, and birds were a constant.

LAeq1hour results remained in a range of 56.6 and 59.9 dBA during the 20 hours of measurement.

4.3 Results of LAeq1hour (dBA) sound levels in Point 3 considering limits for Industrial Area

Table 8 shows the results of the sound levels in LAeq1hour in dBA corresponding to Point 3 of measurement and their contrast with Law No. 1100/97 on the Prevention of Noise Pollution and the international requirements established in the IFC's General Guidelines on Environment, Health and Safety for the Industrial Area.

Regarding the contrast of the results obtained with the IFC's General Guidelines on the Environment, Health and Safety, it was possible to detect in the hours of 06:33:12 and 07:33:12 values that exceed what is allowed, in the rest of the schedules values below 70 dBA were presented.

With regard to compliance with Law No. 1100/97, total compliance was observed between 07:00 and 20:00; However, from 20:00 to 07:00 the levels were higher than what is allowed by law at all times.

Table 8. Compliance with national and international regulations of the results of the sound levels LAeq1hora (dBA) in Point 3 – Industrial Area

Point	Time	Cumulative sound level $LAeq_{1hora}$ (dBA)	Compliance			
			Law No. 1100/97 on the Prevention of Noise Pollution		IFC General Environmental, Health and Safety Guidelines	
			07:00 to 20:00	20:00 to 07:00	07:00 to 22:00	22:00 to 07:00
			75 dBA	60 dBA	70 dBA	
3 – Main access to the neighbours' house	05:33:12	61,2*		×	✓	
	06:33:12	73,14897839*		×	×	
	07:33:12	71,04904653	✓		×	
	08:33:12	70,17712384	✓		✓	
	09:33:12	69,80148867	✓		✓	
	10:33:12	69,65807204	✓		✓	
	11:33:12	69,61756739	✓		✓	
	12:33:12	69,12150994	✓		✓	
	13:33:12	68,66589614	✓		✓	
	14:33:12	68,37534767	✓		✓	
	15:33:12	68,11324953	✓		✓	
	16:33:12	67,74555474	✓		✓	
	17:33:12	67,38566265	✓		✓	
	18:33:12	67,0629521	✓		✓	
	19:33:12	66,80702657	✓		✓	
	20:33:12	66,51956989		×	✓	
	21:33:12	66,25814196		×	✓	
	22:33:12	66,01255585		×	✓	
	23:33:12	65,79616673		×	✓	
	00:33:12	65,57730409		×	✓	

Point	Time	Cumulative sound level LAeq1hora (dBA)	Compliance			
			Law No. 1100/97 on the Prevention of Noise Pollution		IFC General Environmental, Health and Safety Guidelines	
			07:00 to 20:00	20:00 to 07:00	07:00 to 22:00	22:00 to 07:00
			75 dBA	60 dBA	70 dBA	
	01:33:28	65,37485103		×	✓	

*The maximum recorded value of LAeq1hour was 73.1 dBA; while the minimum value of LAeq1hour was 61.2 dBA.

4.3.1 Behaviour of sound levels in Point 3 considering limits for Industrial Area

Figure 4 shows the behavior of the instantaneous sound levels per second in dB recorded during the total measurement time, as well as the results obtained from LAeq1hour in dBA. In addition, the figure shows the lines that represent the maximum permitted values established in Law No. 1100/97 on the Prevention of Noise Pollution (red line) and the IFC's General Guidelines on the Environment, Health and Safety (orange line).

The highest noise levels were produced by the different activities related to the care and maintenance of the farm. In addition, another source that generated sound levels that was perceived from the measurement point were the mobile sources that traveled at high speeds along the Villeta-Alberdi Route.

According to the conditions in which the measurements were carried out, the possibility that a source generating sound levels from the property where the Industrial Plant would be installed could produce exposure levels that could affect the inhabitants of the house of the neighboring property is ruled out.

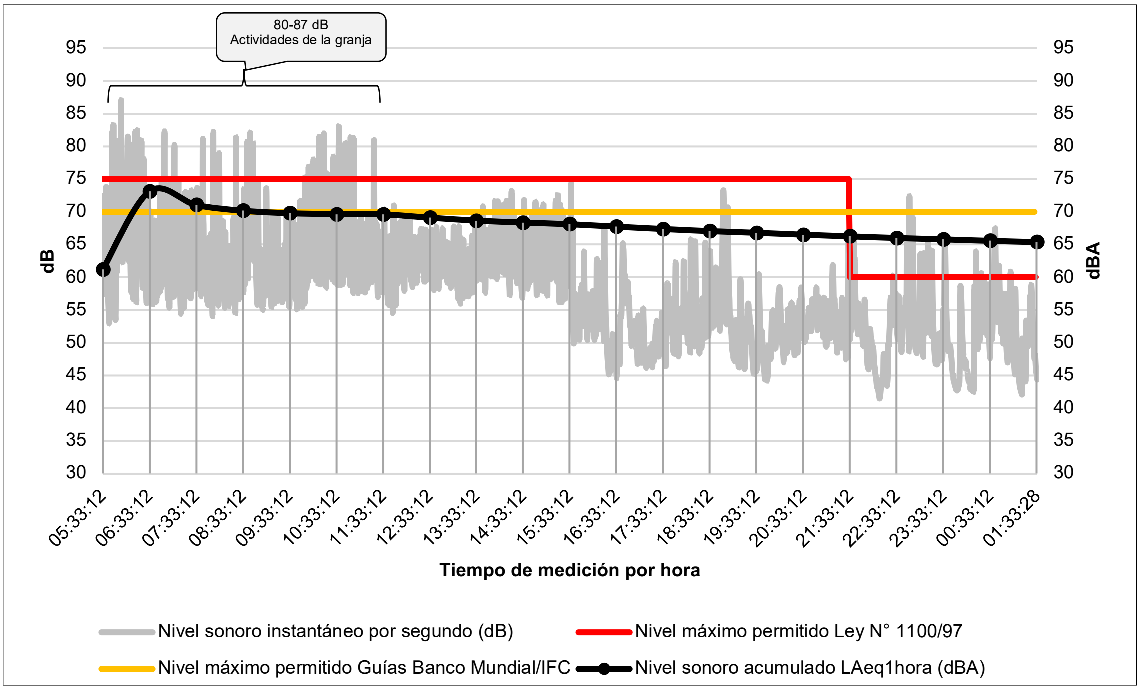


Figure 4. Behaviour of LAeq1hour (dBA) sound levels and their contrast with national and international regulations in Point 3 - Industrial Area.

The minimum instantaneous sound level recorded was 41.5 dB; and the average yielded a value of 57.7 dB.

LAeq1hour results remained in a range of 61.2 and 73.1 dBA during the 20 hours of measurement.

4.3 Results of LAeq1hour (dBA) sound levels in Point 3 considering limits for Residential Area

Table 9 shows the results of the sound levels in LAeq1hour in dBA corresponding to Point 3 of measurement and their contrast with Law No. 1100/97 on the Prevention of Noise Pollution and the international requirements established in the IFC's General Guidelines on Environment, Health and Safety for the Residential Area.

In the contrast of the LAeq1hour results in dBA with both regulations, it was found that in all cases the maximum allowed in each of the schedules is exceeded.

Table 10. Compliance with national and international regulations of the results of the sound levels LAeq1hour (dBA) in Point 3 – Residential Area

Point	Time	Cumulative sound level $LAeq_{1hora}$ (dBA)	Compliance			
			Law No. 1100/97 on the Prevention of Noise Pollution		Guías Generales sobre Medio Ambiente, Salud y Seguridad de la IFC	
			07:00 to 20:00	20:00 a 07:00	07:00 a 22:00	22:00 a 07:00
			60 dBA	45 dBA	55 dBA	45 dBA
3 – Main access to the neighbours' home	05:33:12	61,2*		×		×
	06:33:12	73,14897839*		×		×
	07:33:12	71,04904653	×		×	
	08:33:12	70,17712384	×		×	
	09:33:12	69,80148867	×		×	
	10:33:12	69,65807204	×		×	
	11:33:12	69,61756739	×		×	
	12:33:12	69,12150994	×		×	
	13:33:12	68,66589614	×		×	
	14:33:12	68,37534767	×		×	
	15:33:12	68,11324953	×		×	
	16:33:12	67,74555474	×		×	
	17:33:12	67,38566265	×		×	
	18:33:12	67,0629521	×		×	
	19:33:12	66,80702657	×		×	
	20:33:12	66,51956989		×	×	
	21:33:12	66,25814196		×	×	
	22:33:12	66,01255585		×	×	
	23:33:12	65,79616673		×		×
	00:33:12	65,57730409		×		×
	01:33:28	65,37485103		×		×

*The maximum recorded value of LAeq1hour was 73.1 dBA; while the minimum value of LAeq1hour was 61.2 dBA.

4.3.1 Behavior of sound levels in Point 3 considering limits for Residential Area

Figure 5 shows the behavior of the instantaneous sound levels per second in dB recorded during the total measurement time, as well as the results obtained from LAeq1hour in dBA. In addition, the figure shows the lines that represent the maximum permitted values established in Law No. 1100/97 on the Prevention of Noise Pollution (red line) and the IFC's General Guidelines on the Environment, Health and Safety (orange line).

The highest noise level recorded was 87 dB, produced by the different activities of the inhabitants of the house, mainly related to the care and maintenance of the farm, such as the use of wheelbarrows to transport balance bags to feed the animals, the use of edgers and weeders to clear the land and the circulation of motorcycles to access the farm. Also in the morning, during the measurements, the farm managers were observed carrying out repair activities on the zinc-coated galvanized sheet metal roof of the barn, producing sound levels due to the succession of continuous blows with the hammer through the metal.

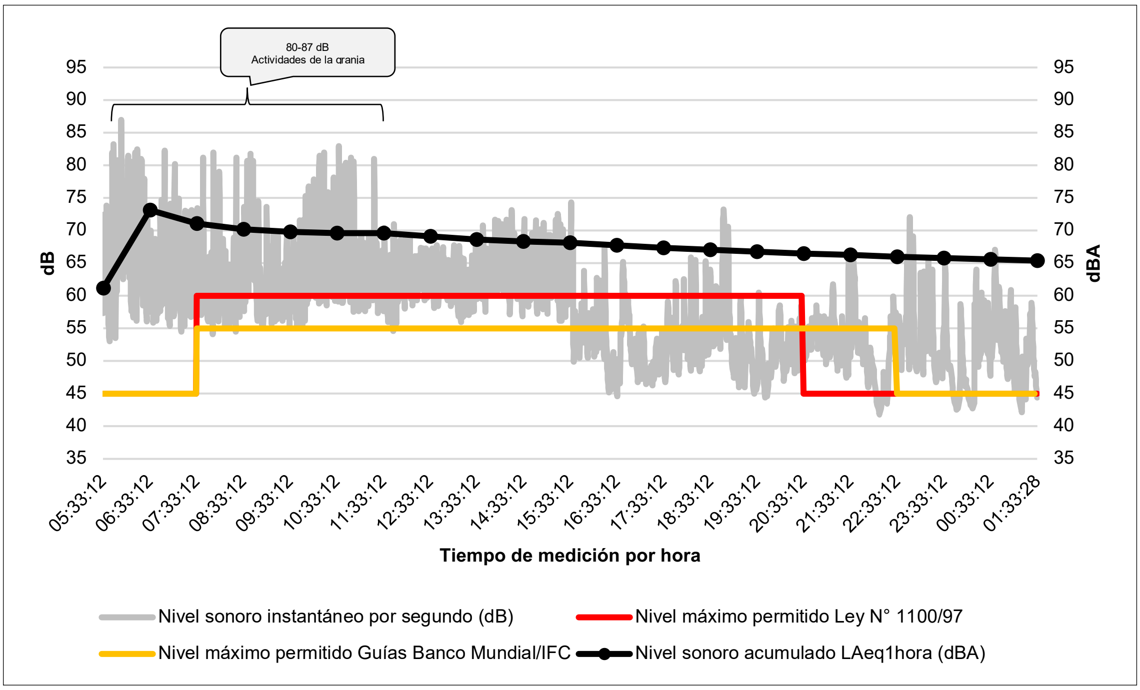


Figure 5. Behaviour of the LAeq1hour (dBA) sound levels and their contrast with national and international regulations in Point 3 – Residential Area.

Other main sources that contributed to high noise levels were the barking of the 4 canines on the farm. Other instantaneous sound level values are also related to the constant transit of different types of farm animals and their own characteristic sounds, becoming sound sources.

4.5 Results of sound levels LAeq1hour (dBA) in Point 4

Table 11 shows the results of the sound levels in LAeq1hour in dBA corresponding to Point 4 of measurement and their contrast with Law No. 1100/97 on the Prevention of Noise Pollution and the international requirements established in the IFC's General Guidelines on the Environment, Health and Safety.

The total compliance of the results obtained with the provisions of the IFC's General Guidelines on Environment, Health and Safety is highlighted.

With regard to compliance with Law No. 1100/97, it was only possible to detect at 05:51:00 a value that exceeds that allowed by law.

Table 11. Compliance with national and international regulations of the sound levels results LAeq1hora (dBA) in Point 4.

Point	Time	Cumulative noise level $LAeq_{1hora}$ (dBA)	Compliance			
			Law N° 1100/97		IFC Guidelines	
			07:00 to 20:00	20:00 to 07:00	07:00 to 22:00	22:00 to 07:00
			75 dBA	60 dBA	70 dBA	
4 - Future area of fixed noise-emitting sources	05:51:00	63,2*		×	✓	
	06:51:00	55,01006306		✓	✓	
	07:51:00	54,87408975	✓		✓	
	08:51:00	53,5705438	✓		✓	
	09:51:00	55,17344041	✓		✓	
	10:51:00	54,46582421	✓		✓	
	11:51:00	53,79619023	✓		✓	
	12:51:00	53,27662597	✓		✓	
	13:51:00	52,93351851	✓		✓	
	14:51:00	52,9336212*	✓		✓	
	15:51:00	54,59271033	✓		✓	
	16:51:00	55,78908322	✓		✓	
	17:51:00	55,87865794	✓		✓	
	18:51:00	55,80355215	✓		✓	
	19:51:00	55,64230626	✓		✓	
	20:51:00	55,45257598		✓	✓	
	21:51:00	55,25446216		✓	✓	
	22:51:00	55,05381386		✓	✓	
	23:51:00	54,97782434		✓	✓	
	00:51:00	54,96970173		✓	✓	
	01:51:16	54,84299224		✓	✓	

*The maximum recorded value of LAeq1hour was 63.2 dBA; while the minimum value of LAeq1hour was 52.9 dBA.

4.5.1 Behaviour of sound levels in Point 4

Figure 6 shows the behavior of the instantaneous sound levels per second in dB recorded during the total measurement time, as well as the results obtained from LAeq1hour in dBA. In addition, the figure shows the lines that represent the maximum permitted values established in Law No. 1100/97 on the Prevention of Noise Pollution (red line) and the IFC's General Guidelines on the Environment, Health and Safety (orange line).

The value of 80.5 dB was the highest recorded, this could be presumed to be due to an isolated case, that according to the characteristics of the site where the sound level meter was located, flocks of parrots *(Tu'i karanda'y)* were observed that could have been perched by the equipment or with their song could have become sound sources. Also, during the measurements, the presence of a fox (*Aguara'i) could be observed*, an animal characterized by its cunning and curiosity, so it could also be presumed that at some point it could have approached the measuring equipment.

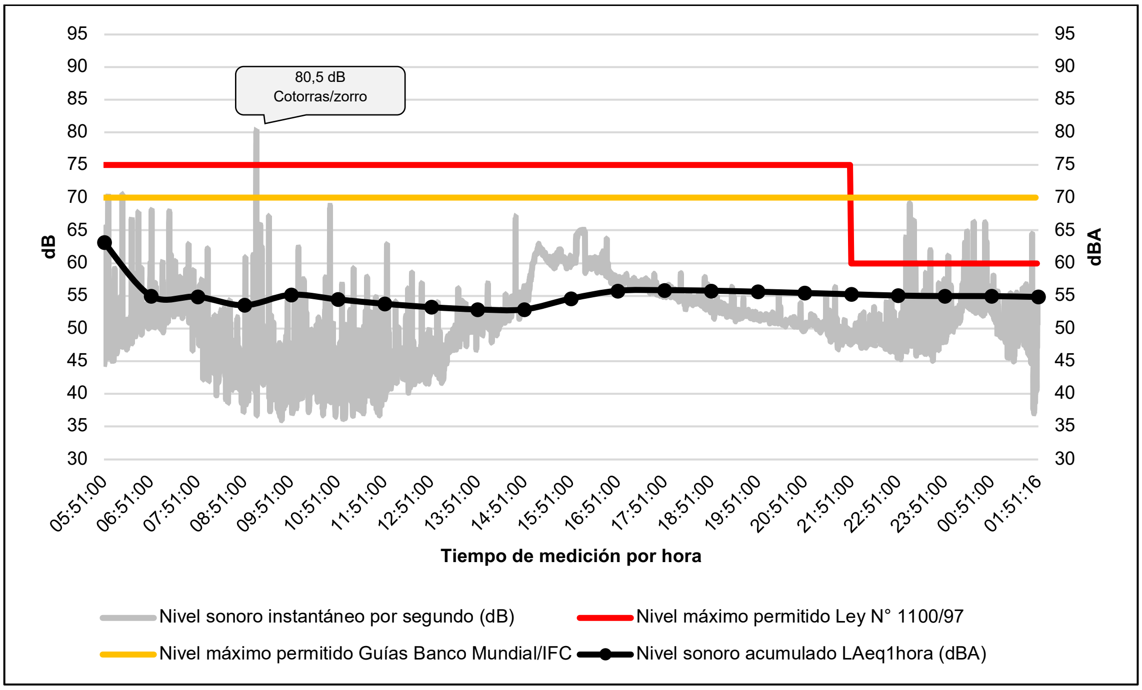
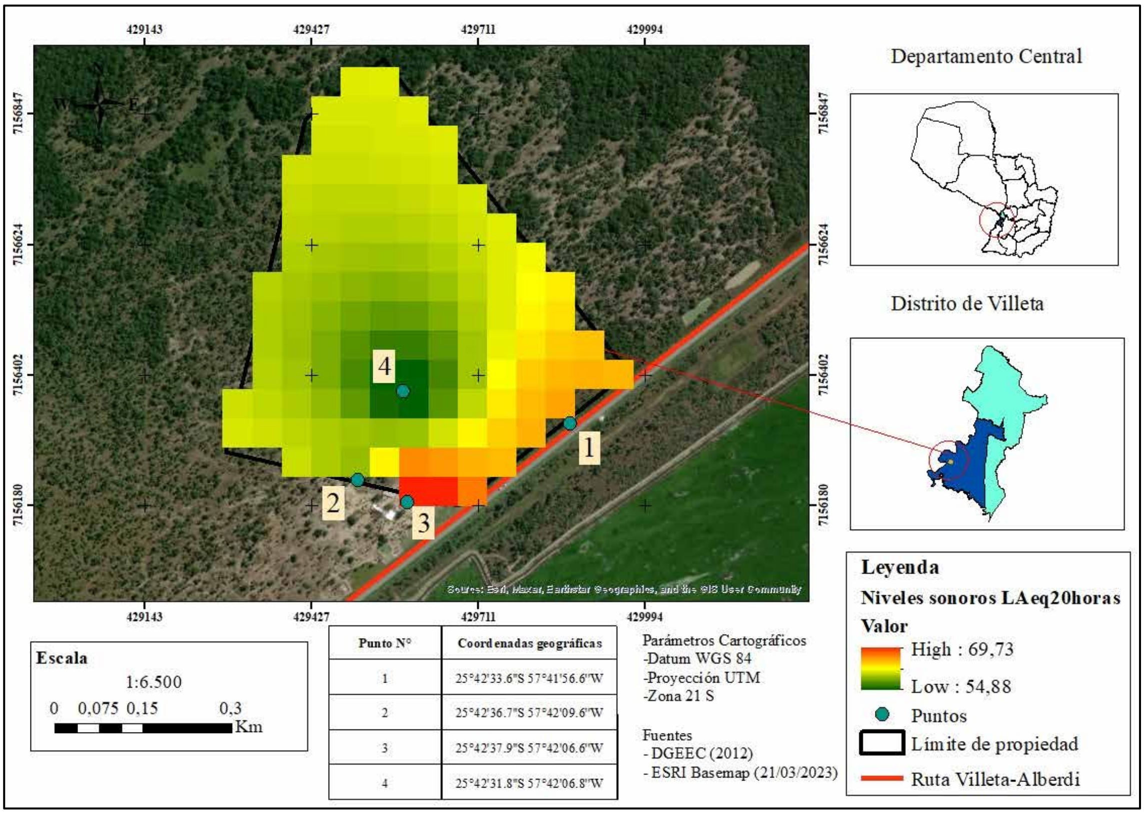


Figure 6. Behaviour of LAeq1hour (dBA) sound levels and their contrast with national and international regulations in Point 4.

The minimum instantaneous sound level recorded was 36 dB; and the average yielded a value of 50.8 dB; which would be practically the levels that were maintained in the vicinity of the measurement point (in the absence of any external source) produced by different types of insects, amphibians, birds.

The LAeq1hour results remained in a range of 52.9 and 63.2 dBA during the 20 hours of measurement.

Figure 7 shows the sound map of the behavior of the LAeq20 hours sound levels in the study area.



Punto N°	Coordenadas geográficas
1	25°42'33.6"S 57°41'56.6"W
2	25°42'36.7"S 57°42'09.6"W
3	25°42'37.9"S 57°42'06.6"W
4	25°42'31.8"S 57°42'06.8"W

Figura 7. Sound map showing the behaviour of sound levels $LAeq_{20horas}$.

5. CONCLUSIONS

It was possible to monitor the sound levels in compliance with all the requirements established in the terms of reference provided for the consulting service.

All appropriate controls and procedures were applied to carry out the measurements of sound levels.

The peak instantaneous sound levels were maintained in a range of 80.5 and 89.4 dB between the 4 recording points during the 20 hours of measurement, which were produced by sources outside the property or by the activities of the farm adjacent to it.

Instantaneous sound levels were maintained in a range of 36 and 89.4 dB between the 4 recording points during the 20 hours of measurement

LAeq1hour levels were maintained in a range of 52.9 and 73.1 dBA between the 4 recording points during the 20 hours of measurement.

In Point 1, a level of compliance of 66.7% was recorded with reference to Law No. 1100/97 on the Prevention of Noise Pollution. The IFC's General Guidelines on Environment, Health and Safety were 100% compliant.

In Point 2, a level of compliance of 100% was recorded with reference to Law No. 1100/97 on the Prevention of Noise Pollution. The IFC's General Guidelines on Environment, Health and Safety also recorded 100% compliance.

For the analysis of Point 3 and its contrast as an Industrial Area, a level of compliance of 62% was recorded with reference to Law No. 1100/97 on the Prevention of Noise Pollution. The IFC's General Guidelines on Environment, Health and Safety were 90% compliant.

Regarding the analysis of point 3 and its contrast as a Residential Area, a level of compliance of 0% was recorded with reference to Law No. 1100/97 on the Prevention of Noise Pollution and the IFC's General Guidelines on the Environment, Health and Safety.

In Point 4, a level of compliance of 95% was recorded with reference to Law No. 1100/97 on the Prevention of Noise Pollution. The IFC's General Guidelines on Environment, Health and Safety were 100% compliant.

In general, at the 4 recording points during the 20 hours of measurement, there was a level of compliance of 81% for Law No. 1100/97 on the Prevention of Noise Pollution. The IFC's General Guidelines on Environment, Health and Safety were 98% compliant.

The results obtained will constitute a fundamental input to fulfill the purpose of the consultancy, which is to carry out the modeling of the propagation of sound levels.

6. TECHNICAL TEAM

Table 12. Technical Team

Nombre y Apellido	Función
Bruno Lovera	Environmental Technician coordinator of the measurements, field collaborator
Eng. Amb. César Fleitas Franco	Professional Technician registered by the Ministry of Labour, Employment and Social Security
Eng. Amb. Julio Bordón Gadea	Field collaborator for measurements, data processing and reporting
Osvaldo Avalos Jara	Trained field collaborator to perform the measurements

7. REFERENCES

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8. ATTACHMENTS

8.1 Technical Specifications of Sound Level Meters

Table 13. Technical specifications of the PCE-322A sound level meter.

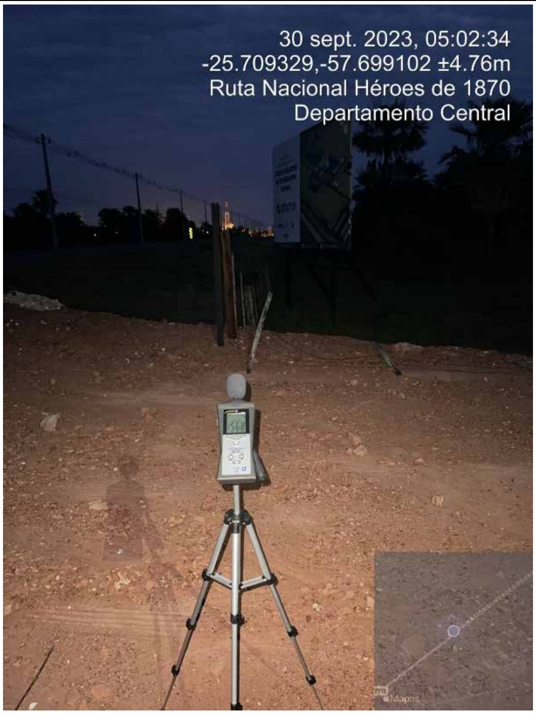
Technical Specifications		Illustrative Image
Measuring Ranges	Low: 30 a 80 dB	
	Medium: 50 a 100 dB	
	High: 80 a 130 dB	
	Auto: 30 a 130 dB	
Resolution	0,1 dB	
Precision	±1,4 dB	
Frequency	31,5 Hz a 8 kHz	
Memory	Approx. 32700 data + 32 GB memory card (accessory)	
Frequency Weighting	A - C	
Microphone Type	Electret Capacitor	
Functions	Values MIN, MAX, HOLD	
Operating Conditions	0 a 40 °C	
	< 90 % H.r.	
Power Source	Batery of 9 V	
Dimensions	280 x 95 x 45 mm	
Weight	Aprox. 350 g. (without batteries)	
Type	Class II	
Compliance with international standard	IEC61672-1	

Tabla 14. Technical specifications of the Minipa MSL-1355B

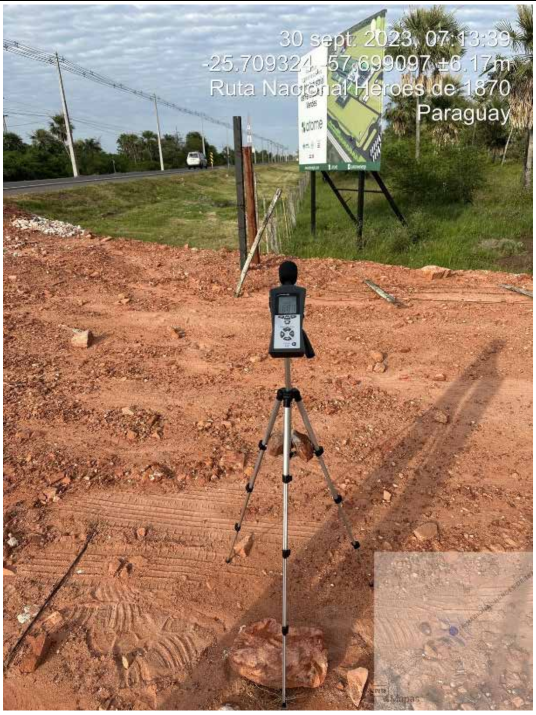
Technical Specifications		**Illustrative Image**
Resolution	0,1 dB	
Frequency Weighting	A – C	
Response Time	Fast - Slow	
Datalogger (memoria)	Approx. 4422 data points	
Datalogger Time Interval	From 1 to 250 seconds	
Battery life	Approx. 20 hours of continuous use	
Operating Conditions	0°C – 40°C	
	HR ≤ 80%	
Dimensions	256 x 70 x 35 mm	
Weight	244 g (without batteries)	
Measuring Ranges	30 a 80 dB	
	30 a 130 dB	
	50 a 100 dB	
	60 a 110 dB	
	80 a 130 dB	
Precision	±1,5 dB	
Frequency	31,5 Hz a 8,5 kHz	
Type	Class II	
Compliance with international standard	IEC PUB 651	

8.2 Photographic record of measurements

Point 1. Main access to the property



Photograph 1. Monitoring of Sound Levels in the morning hours



Photograph 2. Monitoring of Sound Levels in the morning hours

Photograph 3. Monitoring of Sound Levels at Point 1 at noon

Photograph 4. Monitoring of Sound Levels at Point 1 in the afternoon

Point 1. Main access to the property	
 	
Photograph 5. Monitoring of Sound Levels at night	Photographs 5 and 6. Monitoring of Sound Levels at night

Point 2. ATOME Property Boundary – Near Neighbor's Barn

Photograph 7. Monitoring of Sound Levels in the morning hours.

Photograph 8. Monitoring of Sound Levels in the morning hours.

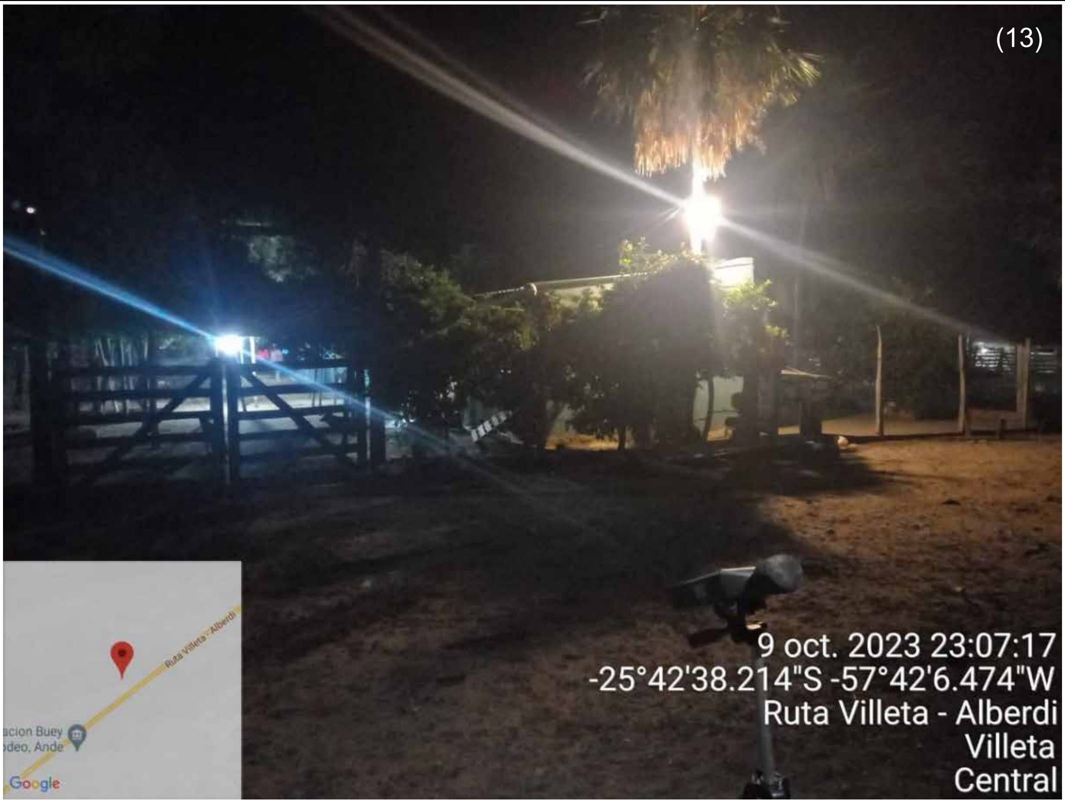
Photograph 9. Monitoring of Sound Levels in the Afternoon

Photograph 10. Monitoring of Sound Levels at night

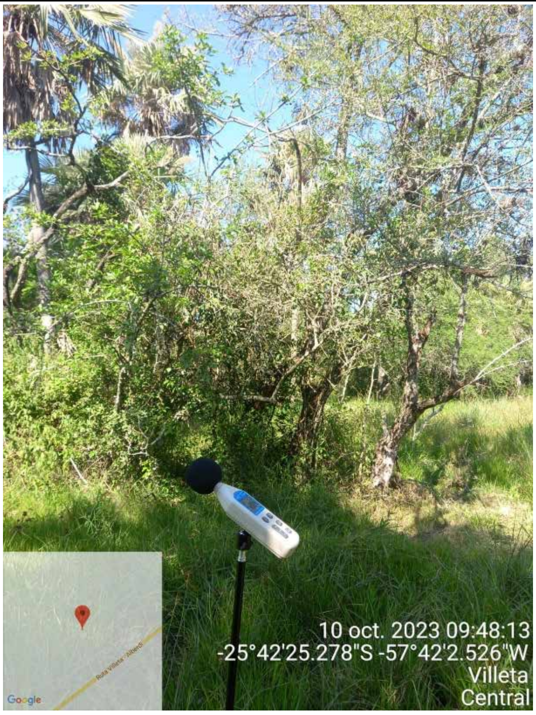
Point 3. Main access to the neighbours' house.

Photograph 11. Monitoring of Sound Levels in the morning hours

Photograph 12. Monitoring of Sound Levels in the morning hours.

Point 3. Main access to the neighbours' house.

Photographs 13 and 14. Monitoring of Sound Levels at night

Photograph 14. Monitoring of Sound Levels at night

Punto 4. Futura zona de fuentes fijas emisoras de ruido	
	
Photograph 15. Monitoring of Sound Levels at Point 4 in the morning hours	Photograph 16. Monitoring of Sound Levels at Point 4 in the morning hours
	
Photograph 17. Monitoring of Sound Levels in the morning hours	

8.3 PCE-322A Sound Level Meter Calibration Certificate

LABSOL

CERTIFICADO DE CALIBRACIÓN

SERVICIO ACREDITADO

Organismo Nacional de Acreditación
NP-ISO/IEC 17025:2018
LC009

Certificado N°: LS20977-2023

1. SOLICITANTE:	JULIO BORDON
Dirección:	Lomas Valentinas c/ Campo Via – Fdo. de la Mora
RUC:	3183136-2

2. DATOS DEL EQUIPO CALIBRADO

Instrumento:	SONOMETRO	N° de Serie:	180924367
Identificación:	SON-01	Intervalo:	(94 a 114) dB
Marca:	PCE	Resolución:	0,1 dB
Modelo:	322A	Tipo:	DIGITAL

3. PATRONES UTILIZADOS

Identificación:	PCA-01	PCT-35	---	---
Descripción:	Calibrador acústico	Termohigrometro	---	---
Certificado:	122.855	LS19107-2023	---	---
Próx. Calibración:	2024-02	2024-06	---	---

4. DATOS DE CALIBRACIÓN

Fecha de calibración:	2023-09-28
Lugar de calibración:	Laboratorio LABSOL
Temperatura:	22,6 °C
Humedad Relativa:	55 %
Procedimiento/s:	LS-PRO-C37 Rev.01

5. ABREVIATURAS

IP:	Promedio de indicacion del patrón
IEC:	Promedio de indicacion del equipo calibrado
E:	Error de medición
U:	Incertidumbre de medición
k:	Factor de cobertura

Realizado por: Tomás Duarte
Código: ID2022LS028

Autorizado por: Andrea Fernandez
Código: ID2017LS008

6. OBSERVACIONES

La incertidumbre expandida de medida informada se expresa como la incertidumbre de medida estándar multiplicado por el factor de cobertura k con una probabilidad correspondiente a aproximadamente del 95%.
La incertidumbre típica combinada fue determinada en conformidad con el documento Guía para la Expresión de la incertidumbre en las mediciones (GUM).

Firmado digitalmente por ANDREA BEATRIZ FERNANDEZ BAEZ

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Tel. +59521 202 846
E-Mail. info@labsol.com.py
Dirección. Tte. Jara Troche 346
Asunción, Paraguay

ADVERTENCIAS:
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c) Los resultados presentados se refieren a las condiciones en las que se realizaron las mediciones.

Página 1 de 2

LS-FOR-038 Rev.06
Vigencia: 2021-03-11

8.3 PCE-322A Sound Level Meter Calibration Certificate (Continued)

LABSOL

CERTIFICADO DE CALIBRACIÓN

SERVICIO ACREDITADO

Organismo Nacional de Acreditación
NP-ISO/IEC 17025:2018
LC009

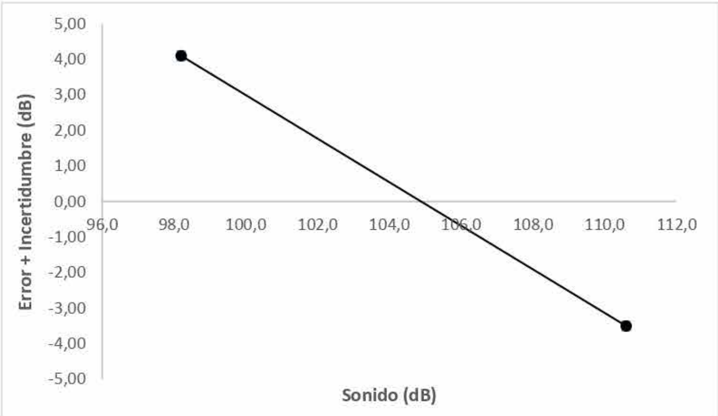
Certificado N°:	LS20977-2023

7. RESULTADOS

SONIDO (dB)

IP (dB)	IEC (dB)	E (dB)	U (dB)	k
94,1	98,2	4,10	0,12	2,00
114,1	110,6	-3,50	0,12	2,00

RESULTADO GRÁFICO DE LA CALIBRACIÓN



8. FECHA DE EMISIÓN DEL CERTIFICADO:	2023-10-02

--- FIN DEL CERTIFICADO ---

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c) Los resultados presentados se refieren a las condiciones en las que se realizaron las mediciones.

Página 2 de 2

LS-FOR-038 Rev.06
Vigencia: 2021-03-11

8.4 Minipa MSL-1355B Sound Level Meter Calibration Certificate

LABSOL

CERTIFICADO DE CALIBRACIÓN

SERVICIO ACREDITADO

Organismo Nacional de Acreditación
NP-ISO/IEC 17025:2018
LC009

Certificado N°: LS20702-2023

1. SOLICITANTE:	TECNOAMBIENTAL S.R.L.
Dirección:	Jose Viñuales - Fernando de La Mora
RUC:	80070966-7

2. DATOS DEL EQUIPO CALIBRADO

Instrumento:	SONOMETRO	**N° de Serie:**	002182H
Identificación:	DB1	**Intervalo:**	(94 a 114) dB
Marca:	MINIPA	**Resolución:**	0,1 dB
Modelo:	MSL-1355B	**Tipo:**	DIGITAL

3. PATRONES UTILIZADOS

Identificación:	PCA-01	PCT-35	---	---
Descripción:	Calibrador acústico	Termohigrometro	---	---
Certificado:	122.855	LS19107-2023	---	---
Próx. Calibración:	2024-02	2024-06	---	---

4. DATOS DE CALIBRACIÓN

Fecha de calibración:	2023-09-08
Lugar de calibración:	Laboratorio LABSOL
Temperatura:	22,4 °C
Humedad Relativa:	83 %
Procedimiento/s:	LS-PRO-C37 Rev.00

5. ABREVIATURAS

IP:	Promedio de indicacion del patrón
IEC:	Promedio de indicacion del equipo calibrado
E:	Error de medición
U:	Incertidumbre de medición
k:	Factor de cobertura

Realizado por: Juan Velázquez
Código: ID2023LS032

Autorizado por: Andrea Fernandez
Código: ID2017LS008

6. OBSERVACIONES

La incertidumbre expandida de medida informada se expresa como la incertidumbre de medida estándar multiplicado por el factor de cobertura k con una probabilidad correspondiente a aproximadamente del 95%.
La incertidumbre típica combinada fue determinada en conformidad con el documento Guía para la Expresión de la incertidumbre en las mediciones (GUM).

Firmado digitalmente por ANDREA BEATRIZ FERNANDEZ BAEZ

Este documento ha sido firmado digitalmente y tiene validez legal de acuerdo a la Ley 4017/2010

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c) Los resultados presentados se refieren a las condiciones en las que se realizaron las mediciones.

Página 1 de 2
LS-FOR-038 Rev.06
Vigencia: 2021-03-11

8.4 Minipa MSL-1355B Sound Level Meter Calibration Certificate (Continued)

LABSOL

CERTIFICADO DE CALIBRACIÓN

SERVICIO ACREDITADO

Organismo Nacional de Acreditación
NP-ISO/IEC 17025:2018
LC009

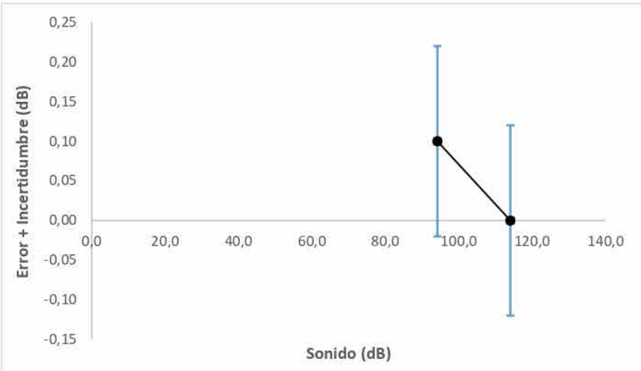
Certificado N°: LS20702-2023

7. RESULTADOS

SONIDO (dB)

IP (dB)	IEC (dB)	E (dB)	U (dB)	k
94,1	94,2	0,10	0,12	2,00
114,1	114,1	0,00	0,12	2,00

RESULTADO GRÁFICO DE LA CALIBRACIÓN



8. FECHA DE EMISIÓN DEL CERTIFICADO: 2023-09-14

--- FIN DEL CERTIFICADO ---

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Asunción, Paraguay

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b) Los resultados presentados se refieren exclusivamente al instrumento descripto en el presente certificado.
c) Los resultados presentados se refieren a las condiciones en las que se realizaron las mediciones.

Página 2 de 2

LS-FOR-038 Rev.06
Vigencia: 2021-03-11

8.5 Technical professional register of the Ministry of Labour, Employment and Social Security of the technician in charge of the measurements

Ministerio de TRABAJO, EMPLEO Y SEGURIDAD SOCIAL

GOBIERNO NACIONAL

Paraguay de la gente

Registrado en:
Dirección de Salud y Seguridad Ocupacional
VICEMINISTERIO DE TRABAJO
Registro Profesional Técnico

Nombre Completo
CESAR AUGUSTO FLEITAS FRANCO

C.I. Nro.
2859882

Foto Carnet

Categoría
Reg. Profesional Renovación A

Fecha Registro
4/9/2023

Fecha Vencimiento
4/9/2025

Annex 6 – Noise Modeling Report

CSI Ingenieros

Assessment of the impact on the acoustic environment – Sound pressure level modelling

November 2023

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1. Introduction

An assessment was made of the acoustic impact that the environment could suffer because of the future operation of ATOME's hydrogen, ammonia, and fertilizer production plant, to be installed in the district of Villeta, in the Central Department of the Republic of Paraguay.

To this end, a sound pressure level modelling (hereinafter NPS) of the operating condition of the industrial plant was carried out, including the main sources of noise generated considered under conservative scenarios. The description and characterization of these sources was provided by URBAS Energy, a company contracted by ATOME, for the development of Engineering and Initial Design of the Plant (FEED).

The modelling carried out made it possible to characterise the future sound environment of the immediate surroundings by studying the propagation of the noise generated by the operation of the industrial plant under regime conditions and characterising the current situation of the area (baseline), determining the incremental contribution of the project and the degree of compliance with the objective acoustic quality values proposed by the regulations and reference guides.

For the analysis, two different scenarios were considered: Esc 1 and Esc 2. The first includes the contribution of the main sound sources foreseen by the project, and the second includes, in addition to the main sound sources, the noise abatement measures currently considered in the engineering design of the project.

The characterization of the current situation (baseline) was carried out by ATOME based on a monitoring campaign in the area. The relevant report is contained in Annex II.

This report is structured in six chapters, which detail the regulations and guidelines used as references, the modelling methodology used, and the characterization of the issues required for modelling, the characterization of the environment (baseline) and, finally, the results and conclusions are presented.

2. Regulations and reference guide

Law No. 6.390/020 of the Republic of Paraguay regulates the emission of noise capable of affecting the well-being or harming the health of persons or living beings, to ensure the due protection of the population, the environment and property affected by exposure to noise. It also regulates that the municipalities will be the authorities in charge of the application of this law and that it is within their duties to establish the regulations associated with emission sources and target acoustic quality levels.

Given that Villeta does not yet have local ordinances that include regulations on the permitted sound pressure levels or target quality as indicated in Law 6.390/020, Law No. 1.100/97 has been taken as a reference, which, despite having been repealed, still represents a starting point for noise regulation in the region. This previous law established objective noise quality values, both for day and night, considering the characterization of land use.

In addition, the noise guidelines established in the General Environmental, Health and Safety Guidelines of the International Finance Corporation (IFC) have also been considered for the assessment.

The following table summarises the acoustic quality objectives of the regulations and reference guidelines according to the land use and the period surveyed.

Table 2-1 Acoustic Quality Objectives (dBA)

Regulations	Period	Land Use		
		Residential Areas	Mixed Areas, Transition Zones	Industrial area
Law No. 1.100/97 Paraguay LAeq, T	Daytime (7 a.m. to 8 p.m.)	60	70	75
	Evening (8 p.m. to 7 a.m.)	45	55	60
IFC Guides LAeq,1h	Daytime (7 a.m. to 10 p.m.)	55	-	70
	Night (10 p.m. to 7 a.m.)	45	-	70

Source: Prepared by the authors based on Law No. 1.110/97 and IFC guidelines

As can be seen, Paraguayan regulations and the IFC guide define the day and night period differently, so explicit mention will be made of which period is being referred to throughout the evaluation carried out.

3. Methodology for calculating and characterizing the aspects required for modelling

The evaluation of the impact on acoustic quality because of the operation of the project was carried out considering two different scenarios at the request of ATOME. The first (Esc 1) corresponds to considering all the main sources of noise emission operating continuously and simultaneously (conservative assumption) without including noise abatement measures that could reduce the emission. The second scenario analysed (Esc 2) arises from considering the previous scenario and adding the noise abatement measures defined during the engineering design of the industrial plant, as additional instruments to mitigate the acoustic impact that the project could generate on the environment.

The description and characterization of noise sources and abatement measures were provided by ATOME.

3.1. Description of the calculation methodology

The CadnaA *software from* DataKustik GmbH *(2020 version) was used for NPS modelling.* This *software* is based on numerical NPS calculation tools through different mathematical models of noise propagation, and, in this particular study, the calculations were based on the ISO 9613 standard for the modeling of industrial complexes, an internationally recognized calculation methodology for NPS modeling of this type of projects.

The *calculation software* used allows the incorporation of georeferenced elements for the development of the terrain model, such as contour lines, forested areas, emitting and receiving sources with their respective heights, among others.

With respect to the propagation calculation, the model considers geometric divergence attenuations[1], atmospheric absorption attenuation[2], ground effect attenuation, attenuations due to the presence of barriers (including buildings, structures, and topography), weather corrections, and wave reflections. The criteria for the determination of attenuation factors were based on the recommendations of ISO 9613 standards.

As a result of the modelling, within the adopted calculation configuration, the *software* returns estimated NPS values at the individual receivers evaluated, as well as an isophone line map for the entire evaluation area (calculation grid).

Regarding the calculation parameters used in this case, a factor of G=1 was considered for the absorption of the land, since most of the propagation area corresponds to porous land, areas covered with grass, trees, or vegetation, taking into account that even within the industrial plant there are green areas. Buildings were considered in all cases as reflective surfaces (G=0). The general order of reflection of the modelling was set in 1st order.

---

[1] $ADiv = 20 \log(d/d)_0) + 11$ dB

[2] For the standard frequency of 500 Hz, the atmospheric absorption attenuation of Aatm = 0.002 dB/m was considered.

3.2. Characterization of emitting sources

The emission sources indicated in the Table 3-1 operating at its maximum emission, continuously and simultaneously, which corresponds to a conservative assumption. These were georeferenced and with their corresponding heights.

The operation of these sources with the characterization indicated in the Table 3-1 was analysed in Scenario 1 (Esc 1).

Table 3-1 Emission data from major sources

Point	Description	Height (m)	Emitted noise (dBA) *
R1a	Air Separation Unit Main Air Compressor (USA)	0,5	85
R1b	USA Air Compressor Reserve	0,5	85
R2	Cooling tower (5 cells)	10	85
R3	Turboset	1	95
R4a	Syngas Main Compressor	1	95
R4b	Syngas compressor reserve	1	95
R4c	NH3 Compressor	1	95
R5	NH3 Synthesis Unit Chiller (x3)	5	85
B2a	Turboset A Room Fans	1,5	84
B2C	Turboset B Room Fans	1,5	84
B4a	Compressor Building Fans A	1,5	84
B4B	Compressor Building Fans B	1,5	84
B4C	C Compressor Building Fans	1,5	84

* 1 m from the equipment (distance at floor level)

Source: Based on information provided by ATOME (URBAS Energy).

During the engineering design of the project, various noise abatement measures were defined, such as specific insulation in buildings or the incorporation of silencers, to act directly on the emission. The details of these are presented in the Table 3-2 and its application was included in the analysis of Scenario 2 (Esc 2). It should be noted that noise abatement measures were not considered in Scenario 1 (Esc 1).

Table 3-2 Characterization of the noise abatement measures considered in Scenario 2

Point	Description	Height (m)	Mitigation Level (dBA)
B1	Turboset encapsulation	1,5	15
B2a	Turboset A Room Fans	1,5	15
B2B	Turboset intake air filter	1,5	15
B2C	Turboset B Room Fans	1,5	15
B3	Compressor Building Encapsulation	1,5	15
B4a	Compressor Building Fans A	1,5	15
B4B	Compressor Building Fans B	1,5	15
B4C	C Compressor Building Fans	1,5	15

Source: Based on information provided by ATOME (URBAS Energy).

3.3. Characterization of the terrain model and calculation grid

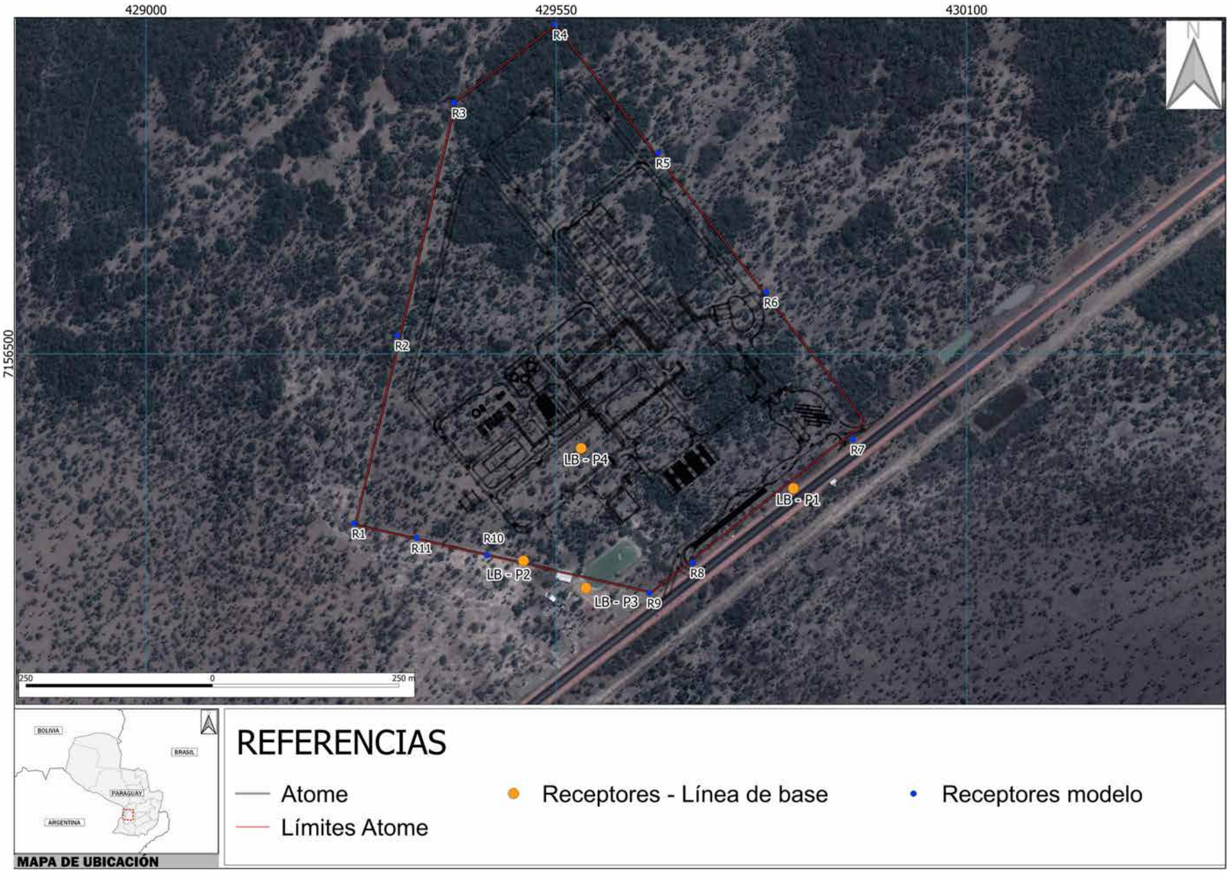
For the construction of the physical model, the general *layout* of the ATOME industrial plant was used (according to the plan "*VILLETA PLANT LAYOUT r05C*"), assigning names and heights to all the buildings, structures and tanks. Appendix I presents the details and characteristics of the buildings considered.

For the definition of the calculation grid, a grid size of 10 m x 10 m and a receiver height of 1.60 m were considered. In addition, particular individual receivers were defined to represent the perimeter of the industrial plant (property boundary) and other sites of particular interest.

Eleven point receptors were defined along the perimeter of the property and four additional receptors were incorporated corresponding to the monitoring sites where the NPS baseline measurements were performed. The LB-P3 receiver corresponds to the nearest inhabited dwelling. All recipients were assigned a height of 1.60 m, a value commonly defined as the average height of a person.

The following figure shows the location of all the point receptors considered.

Figure 3-1 Point Receivers Considered



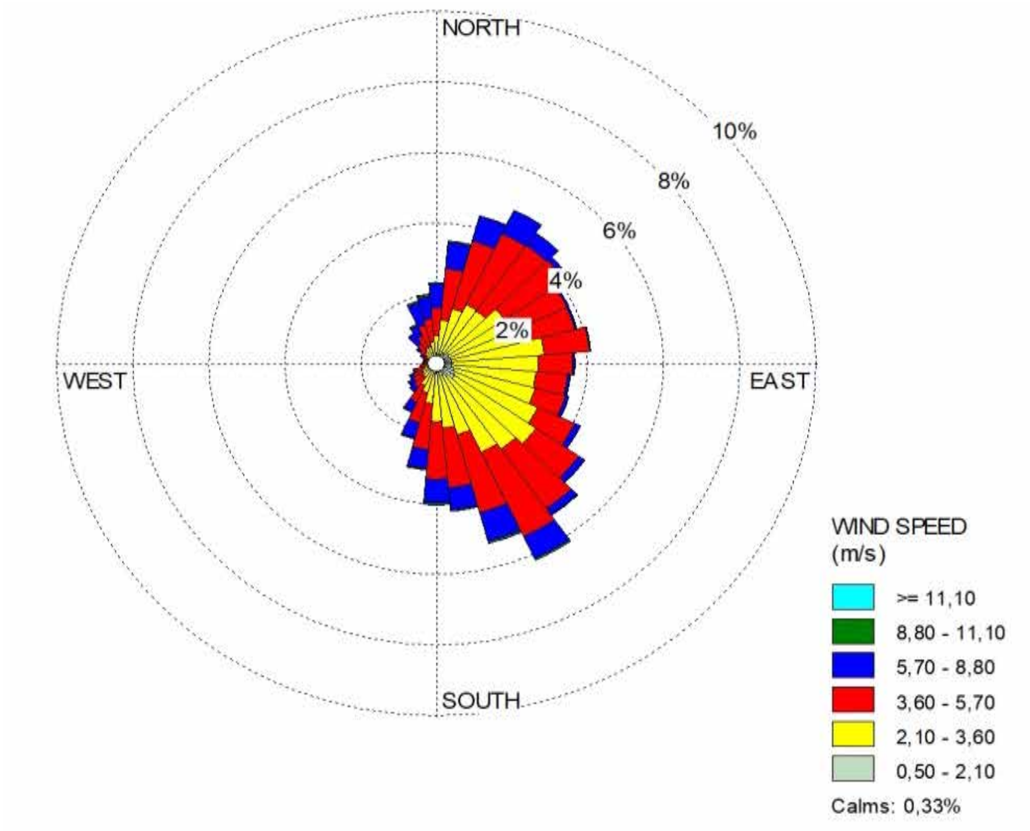
Source: Authors' own creation

3.4. Meteorological characterization

The characterization of the meteorological conditions and the correction required by the calculation method was carried out according to the compass rose presented in the Figure 3-2. This was obtained because of the WRF[3] mesoscale model in the industrial site, for the period of 2017-2021.

[3] The output of the WRF mesoscale model in the area of the industrial site for the period 2017-2021 was acquired from the company Lakes Environmental.

Figure 3-2 Compass Rose – 2017-2021



Source: Authors' elaboration based on the output of the WRF mesoscale model.

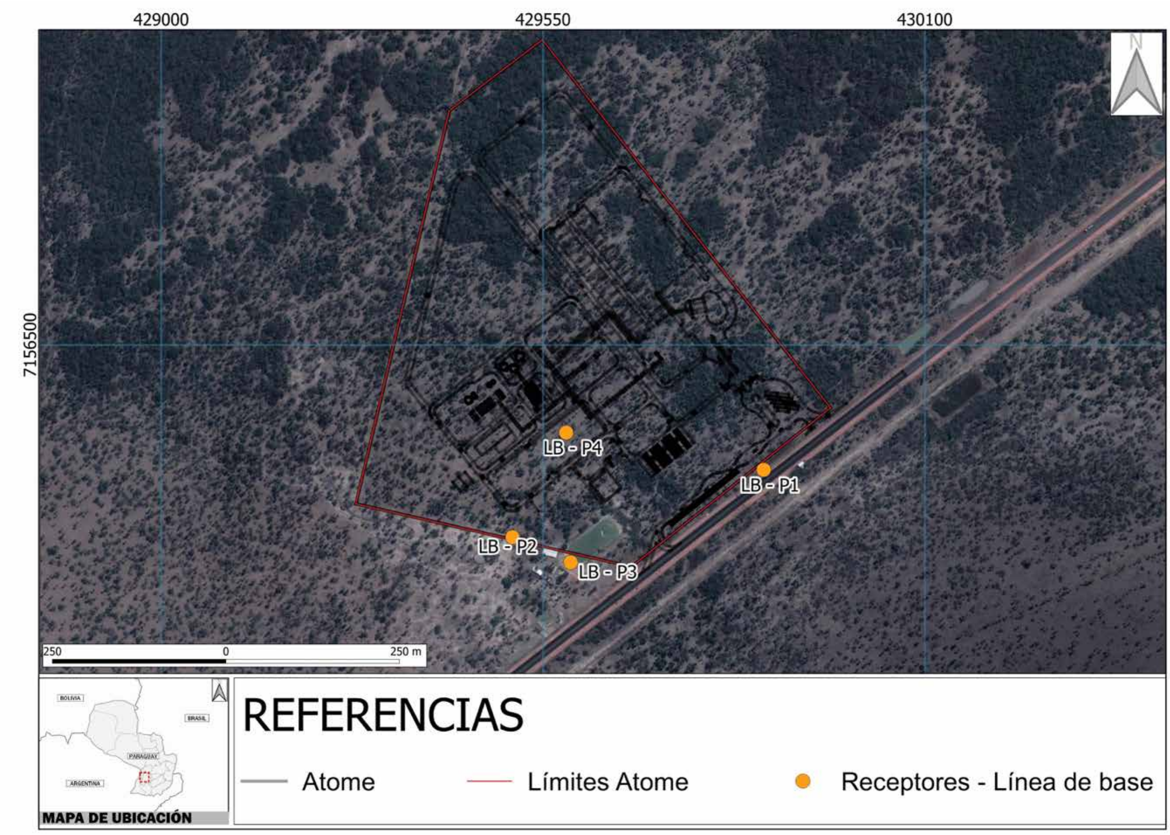
4. Baseline Characterization

The baseline characterization was provided by ATOME and is presented in Annex II.

An NPS measurement campaign was carried out between September 30 and October 10, 2023, during the day and at night, in four selected receivers located in the vicinity of the project, through a single continuous measurement of 20 hours per point.

In the Figure 4-1 You can see the location of the points surveyed and in the Table 4-1 Their coordinates are presented. The neighbouring property located to the south of the project corresponds to a rural productive establishment with animal husbandry (farm).

Figure 4-1 Points surveyed during baseline



Source: Authors' own elaboration based on data provided by ATOME

Table 4-1 Coordinates of monitoring points

Point	UTM Coordinates (21J)	
	East (m)	South (m)
LB - P1	429.867,79	7.156.319,41
LB - P2	429.506,01	7.156.222,12
LB - P3	429.589,81	7.156.185,65
LB - P4	429.583,24	7.156.373,27

Source: ATOME

In the Table 4-2 The values collected during the baseline characterization campaigns carried out by ATOME for the day and night periods are presented. It should be noted that Paraguayan regulations and IFC guidelines consider different periods such as day and night, so the results are expressed indicating the time range considered in each case.

For the purpose of characterizing the day and night periods by means of a single representative value of each period at each point surveyed, the LAeq of the entire measurement period within the time slot considered for each case was considered.[4] Plate 4-1 shows the spatial distribution of the results (obtained from Annex II).

Table 4-2 Baseline Results Surveyed by Period

Receptor	LAeq (dBA)			
	Daytime Paraguay 7 a.m. – 8 p.m.	**IFC Daytime 7 a.m. – 10 p.m.**	**Nocturnal Paraguay 8 p.m. – 7 a.m.**	**IFC Night 10 p.m. – 7 a.m.**
LB - P1	66	65	62	62
LB - P2	58	57	54	55
LB – P3	65	65	66	67
LB – P4	56	55	53	53

Source: Based on Annex II

The baseline characterization report (Annex II) presents observations on the environment and acoustic climate of each of the surveyed points. These observations are transcribed below to better understand the acoustic environment where the project will be inserted.

Point LB – P1 corresponds to the current access point to the project register. It is located very close to the Villeta-Alberdi route. The maximum instantaneous value recorded during the measurement (89 dBA) corresponds to the explosion of one of the tires of a medium-sized cargo truck that was traveling along the road, approximately 30 m from the sound level meter. During the entire measurement, the passage of vehicles, mainly of large size, that travelled along the route was recorded. The circulation of heavy trucks was more frequent at night and in the early morning.

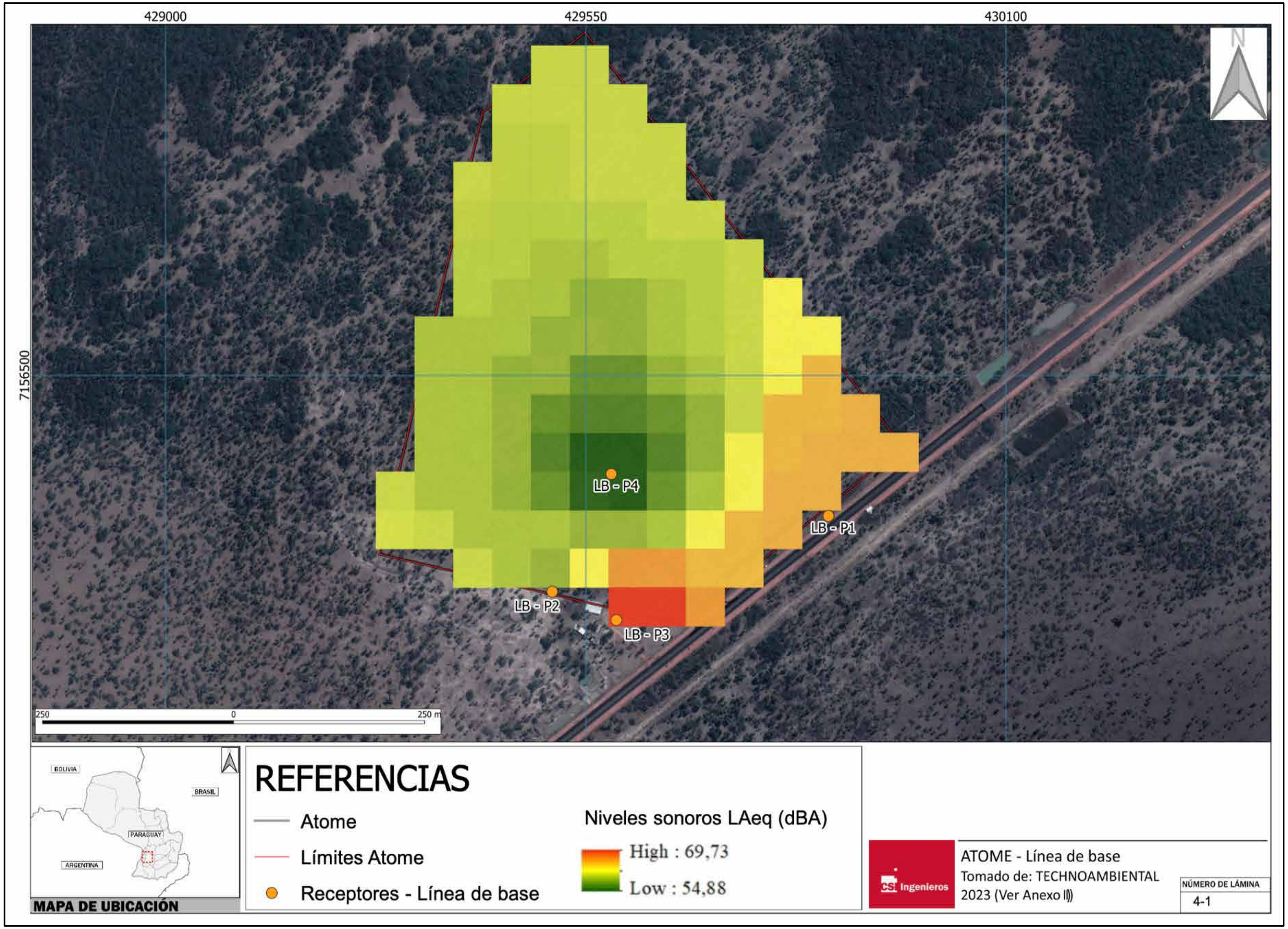
Point LB – P2 is located on the edge of the property, close to an existing stable on the neighbouring property. On this property, a productive rural farm for the breeding of farm animals is developed. The highest instantaneous values were recorded at the times when horses passed through the vicinity of the measurement point neighing and galloping, a situation that corresponded to the departure of these animals from the stable at around 7 am, and their subsequent return at around 4 pm. In addition, in the vicinity of the measurement point there were animals, mainly birds such as chickens, ducks, turkeys, geese and roosters, which roamed freely in the environment, approaching the sound level meter on several

[4] These values were obtained from the processing of data provided by ATOME (Annex II).

occasions. At night and early in the morning, when the farm animals were already sheltering in the barn or in the corrals, the barking of several dogs was identified.

Point LB – P3 corresponds to the dwelling of the rural productive establishment. During the measurement, the members of the house carried out various activities of care and maintenance of the farm, such as the use of wheelbarrows to transport bags of animal feed, the use of edgers and weeders to clear the land, and the circulation of motorcycles in the surroundings. Noise from traffic on the Villeta-Alberdi route was also perceptible during the measurement. During the morning, the execution of repair activities of a galvanized sheet roof was observed, with continuous hammer blows on it and, throughout the measurement, the constant transit of different types of farm animals was observed, emitting their characteristic sounds.

Point LB – P4 is located within the property away from both the Villeta-Alberdi route and the rural establishment located in the neighbouring property to the south. This point is located, approximately, where the infrastructure of the project will be built, which will contain the main sound sources. It is presumed that the maximum instantaneous values recorded (80 dBA) around 9 am correspond to the song of a flock of parrots located very close to the sound level meter.


429000
429550
430100
7156500
N
LB - P4
LB - P1
LB - P2
LB - P3
250
0
250 m
BOLIVIA
BRASIL
PARAGUAY
ARGENTINA
MAPA DE UBICACIÓN
REFERENCIAS
Atome
Límites Atome
Receptores - Línea de base
Niveles sonoros LAeq (dBA)
High : 69,73
Low : 54,88
CSI Ingenieros
ATOME - Línea de base
Tomado de: TECHNOAMBIENTAL
2023 (Ver Anexo II)
NÚMERO DE LÁMINA
4-1

5. Results

The results obtained for the two modelled scenarios, the isophone maps and the estimated immission values in the individual receivers evaluated, as well as their comparison with the standards and reference guidelines, are presented below. Immission values are represented as A-weighted equivalent continuous sound level, which is noted as LAeq.

In the Table 5-1 The estimated values of LAeq are presented for the contribution derived only from the operation of the industrial plant under the conditions described above for Scenario 1 (without considering abatement measures) and for Scenario 2 (considering abatement measures). As can be seen, no value foreseen by the operation of the project exceeds 41 dBA in the individual receivers considered.

Table 5-1 Modelled NPS – Industrial Plant Input

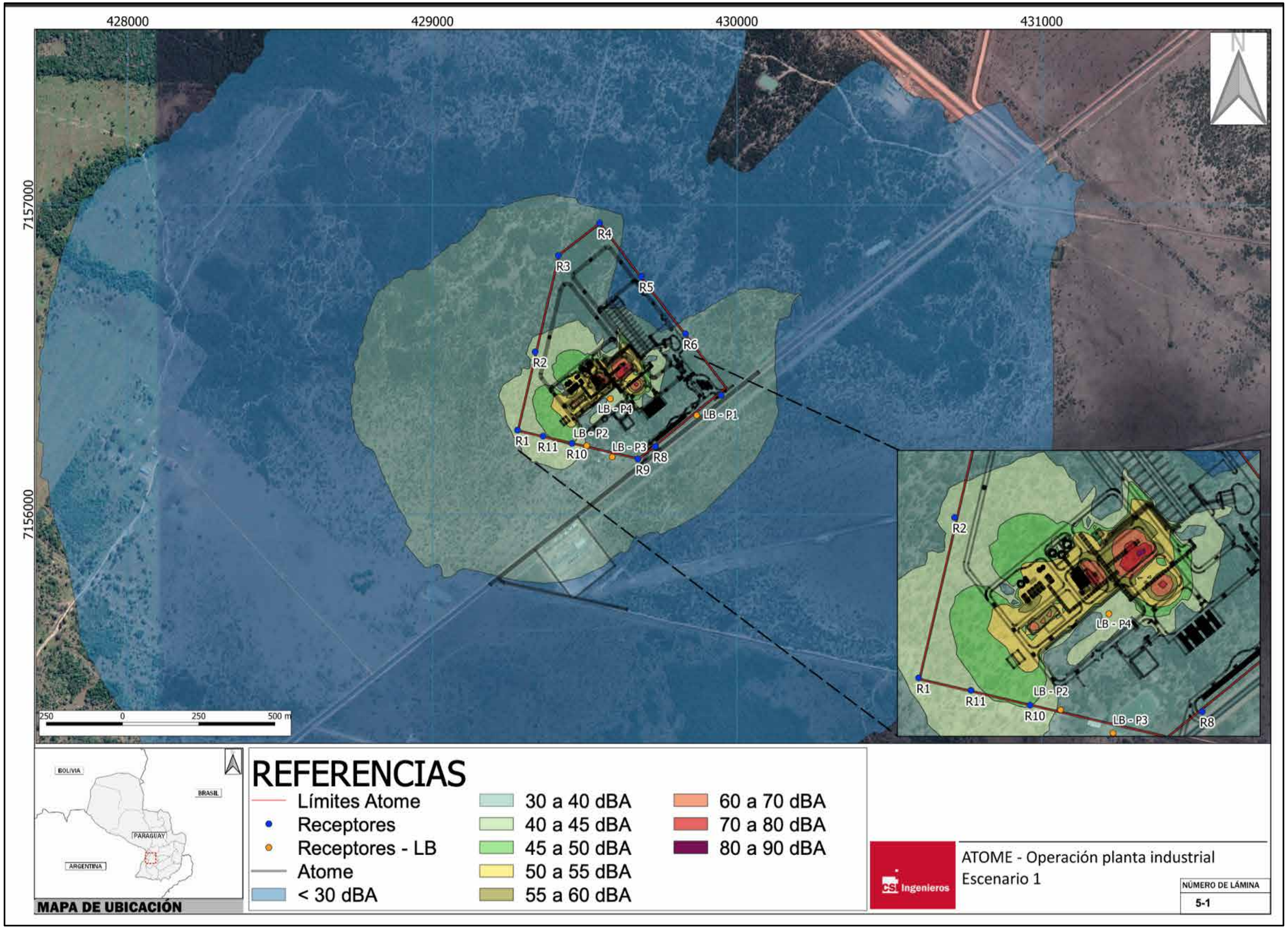
Receptor	Scenario 1 LAeq (dBA)	Scenario 2 LAeq (dBA)
R1	41	41
R2	41	41
R3	34	33
R4	31	30
R5	25	19
R6	35	31
R7	33	30
R8	34	31
R9	33	31
R10	45	45
R11	44	44
LB - P1	34	31
LB - P2	40	39
LB - P3	32	31

Note: The LB-P4 receiver is not evaluated because it is located within the industrial site

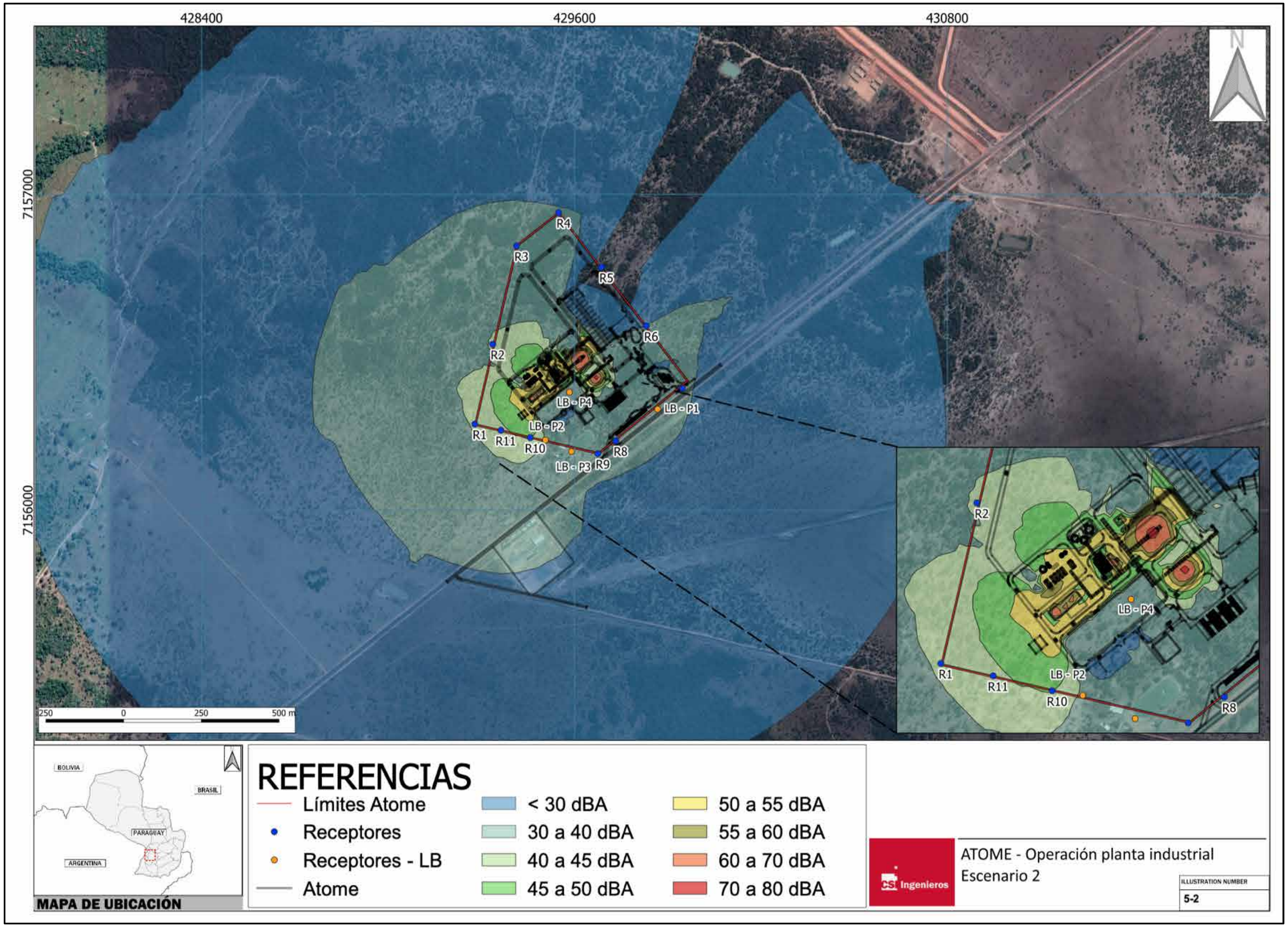
The isophone maps generated by the operation of the industrial plant are presented as graphic figures, according to the following denomination:

- Slide 5–1 Noise Map. Industrial Plant Operation – Scenario 1.
- Slide 5–2 Noise Map. Industrial Plant Operation – Scenario 2.

It should be noted that in the maps presented, the baseline values (Plate 4-1) and the expected contribution from the project operation can be visualized independently in both scenarios (Plate 5-1 and 5-2 respectively). The analysis of the future situation (project + baseline) for each modelled scenario can be seen in the Table 5-2.



428000
429000
430000
431000
7157000
7156000
N
R1
R2
R3
R4
R5
R6
R8
R9
R10
R11
LB - P1
LB - P2
LB - P3
LB - P4
250
0
250
500 m
BOLIVIA
BRASIL
PARAGUAY
ARGENTINA
MAPA DE UBICACIÓN
REFERENCIAS
Límites Atome
Receptores
Receptores - LB
Atome
< 30 dBA
30 a 40 dBA
40 a 45 dBA
45 a 50 dBA
50 a 55 dBA
55 a 60 dBA
60 a 70 dBA
70 a 80 dBA
80 a 90 dBA
CSI Ingenieros
ATOME - Operación planta industrial
Escenario 1
NÚMERO DE LÁMINA
5-1


428400
429600
430800
7157000
7156000
N
R1
R2
R3
R4
R5
R6
R8
R9
R10
R11
LB - P1
LB - P2
LB - P3
LB - P4
250
0
250
500 m
BOLIVIA
BRASIL
PARAGUAY
ARGENTINA
MAPA DE UBICACIÓN
REFERENCIAS
Límites Atome
Receptores
Receptores - LB
Atome
< 30 dBA
30 a 40 dBA
40 a 45 dBA
45 a 50 dBA
50 a 55 dBA
55 a 60 dBA
60 a 70 dBA
70 a 80 dBA
CSI Ingenieros
ATOME - Operación planta industrial
Escenario 2
ILLUSTRATION NUMBER
5-2

The predicted immission values for the future situation (project + baseline) are obtained by the logarithmic sum of the baseline values and of each scenario evaluated (Esc 1 and Esc 2), and are presented in the Table 5-2. In addition, this table presents the values of the current situation (baseline) for the day and night period, and compares the situation with the target acoustic quality values indicated in the reference regulations and guide. Green indicates the receivers that comply with Paraguayan regulations and IFC guidelines, and orange indicates those that do not comply with at least one.

Given that the Paraguayan regulations and the IFC guide consider different time slots for the day and night periods, the highest value revealed among the time slots defined by both standards for these periods is selected as representative of the baseline for the purposes of the comparison sought in each period considered (day and night).

As can be seen, the resulting NPS values in the future situation (project + baseline) are fully determined by the values of the current situation (baseline) since the expected contribution of the project to the evaluated recipients is, in all cases, lower than the current situation by more than 10 dBA. which implies that the operation of the project will not generate an increase in future NPS.

Regarding compliance with the acoustic quality values indicated by the regulations and reference guides, the presence of the project will not change the current level of compliance. It is for this reason that in recipients where the current situation already exceeds the target quality value, the future situation (project + baseline) will also do so in equal quantity. If Paraguayan regulations are considered, this situation occurs in the daytime period only in the LB-P3 receptor (nearest home) and in the nocturnal period in the R7, R8, R9, LB-P1 and LB-P3 receptors. However, if the objective quality value proposed by the IFC is considered, the only point surveyed where compliance is not given is in the PB-P3 receiver (nearest dwelling), where the guide value for residential use was considered. Notwithstanding the above, it should be remembered that the nearest dwelling (LB-P3 receiver) corresponds to a productive rural enterprise where farm activities are carried out and the current situation (baseline) already presents high values that exceed the target quality values to date.

Table 5-2 Predicted NPS values and comparison with regulations and reference guidelines

Receptor	Period	Project Contribution LAeq (dBA)		Baseline * (dBA)	Representative Baseline Point** (dBA)	Future Situation: Project + Baseline (dBA)		Law 1100/97 (dBA)	IFC Guide (dBA)
		Esc 1	Esc 2			Esc 1	Esc 2		
R1	Diurnal	41	41	56	LB-P4	56	56	75	70
	Noct.	41	41	53		53	53	60	70
R2	Diurnal	41	41	56	LB-P4	56	56	75	70
	Noct.	41	41	53		53	53	60	70
R3	Diurnal	34	33	56	LB-P4	56	56	75	70
	Noct.	34	33	53		53	53	60	70
R4	Diurnal	31	30	56	LB-P4	56	56	75	70
	Noct.	31	30	53		53	53	60	70
R5	Diurnal	25	19	56	LB-P4	56	56	75	70
	Noct.	25	19	53		53	53	60	70
R6	Diurnal	35	31	56	LB-P4	56	56	75	70
	Noct.	35	31	53		53	53	60	70
R7	Diurnal	33	30	66	LB-P1	66	66	75	70
	Noct.	33	30	62		62	62	60	70

Receptor	Period	Project Contribution LAeq (dBA)		Baseline * (dBA)	Representative Baseline Point** (dBA)	Future Situation: Project + Baseline (dBA)		Law 1100/97 (dBA)	IFC Guide (dBA)
		Esc 1	Esc 2			Esc 1	Esc 2		
R8	Diurnal	34	31	66	LB-P1	66	66	75	70
	Noct.	34	31	62		62	62	60	70
R9	Diurnal	33	31	65	LB-P3	65	65	75	70
	Noct.	33	31	67		67	67	60	70
R10	Diurnal	45	45	58	LB-P2	58	58	75	70
	Noct.	45	45	55		55	55	60	70
R11	Diurnal	44	44	58	LB-P2	58	58	75	70
	Noct.	44	44	55		55	55	60	70
LB - P1	Diurnal	34	31	66	LB-P1	66	66	75	70
	Noct.	34	31	62		62	62	60	70
LB – P2	Diurnal	40	39	58	LB-P2	58	58	75	70
	Noct.	40	39	55		55	55	60	70
LB – P3	Diurnal	32	31	65	LB-P3	65	65	60	55
	Noct.	32	31	67		67	67	45	45

6. Conclusions

An assessment of the acoustic impact that the immediate surroundings of the ATOME project implementation site could suffer was carried out through the modelling of the NPS of the operating condition of the industrial plant, including the main sources of noise generation under two different scenarios.

The evaluation carried out foresees that there will be no impact on future acoustic quality, given that the levels that the project will provide outside the limits of its property will be marginal compared to the current situation (lower by more than 10 dBA compared to the baseline). In other words, the future acoustic quality of the point receptors evaluated will be determined by the current situation and will not be modified by the presence of the project.

Regarding compliance with the objective quality values established in Paraguayan regulations and IFC guidelines in the future situation, it is not expected that there will be a modification of the current compliance in the recipients surveyed. In other words, those recipients where the current NPS exceeds the target quality values will continue to exceed them in the future and it is not expected that any point recipient evaluated will change its level of compliance when the project starts operating. If the IFC guideline is considered, the LB-P3 receiver is the only point receiver where the target quality value for day and night periods is not met and will not be met in the future situation. If Paraguayan regulations are considered, the same LB-P3 receiver does not and will not comply in the future with the target quality values for both periods, and the same happens for the R7, R8, R9 and LB-P1 receptors at night.

It should be noted that the LB-P3 receiver corresponds to the nearest and only dwelling in the evaluated area, so the land use for the application of Paraguayan regulations and IFC guidelines was considered there as residential only. Notwithstanding the above, it is recalled that this recipient corresponds to a productive rural enterprise where farm activities are carried out and that the current NPS values are among the highest surveyed during the characterization of the current situation (baseline).

ANNEX I

BUILDINGS & TANKS

CSI Ingenieros

Annex Buildings and Tanks

October 2023

1. Introduction

As the first step of the modelling, the physical model of the plant must be assembled, for which the main buildings must be loaded into the model, considering both buildings and tanks.

This annex summarizes the data on heights and considerations taken with respect to these structures.

All tanks and buildings were considered reflective (silent façade/reflective screen), i.e. they have a α acoustic absorption coefficient of 0.21 depending on the model used.

All information on buildings, sources, location, and emission was provided by ATOME.

2. Building & Tank Data

2.1. Buildings

Table 2-1 Height and nomenclature of buildings

Name of the building	Relative height considered (m)
Milling	4
Bulk storage silo	23
Packaged storage building	15
Electrolysers building	13
Syngas compressors building	14
Workshop-warehouse building	7
Electrical building	5,7
Access/Customs Control	4
Granulation Plant	35
Cooling tower	8,7
Nitric Acid Plant	18
Office Buildings	5,5
ANS Plant	21

2.2. Tanks

Table 2-2 Height and nomenclature of tanks

Name of the tank	Radius (m)	Height (m)
FFS Water Tank & Services (x2)	8.81	12
NH3 Tank	5.88	13
NA Tanks x2	5.19	13
ANS Tanks	3.43	9.5
Demi Water Tanks	4.79	7

ANNEX II
NOISE BASELINE

Annex 5 – Sound Pressure Level Monitoring Report (Baseline)

SOUND PRESSURE LEVEL MONITORING RESULTS REPORT

PROJECT:
PLANTA INDUSTRIAL ATOME S.A.

CUSTOMER:	ATOME S.A.
DISTRICT:	VILLETA
DEPARTAMENTO:	CENTRAL
CONSULTANT:	TECNOAMBIENTAL S.R.L
CTCA CODE:	E-133

October 2023

1. INTRODUCTION

ATOME Paraguay S.A., hereinafter *"The Company"*, is developing an industrial project to be installed on a 30-hectare property in the district of Villeta. The industry will be the first dedicated to the production of hydrogen, ammonia and green fertilizers.

The company contracted Tecnoambiental S.R.L. to carry out the environmental noise survey with the aim of collecting data on current noise levels, evaluating and comparing with the maximum permissible limits established in national legislation and the General Guidelines on the Environment, Health and Safety (MASS) of the International Finance Corporation (IFC)/World Bank.

The survey was carried out on September 30 and October 9, 2023, in places defined jointly with *The Company*. These were established within the property; specifically considering the location of future major sources of noise emission, and off-property; taking into account the presence of critical receptors.

The regulatory framework, methodology and results of the noise measurement campaign are described below.

2. REGULATORY FRAMEWORK

2.1 National

2.1.1 Law No. 6390/20 Regulating Noise Emission

The purpose of this law is to regulate the emission of noise capable of affecting the well-being or damaging the health of people or living beings, in order to ensure the due protection of the population, the environment and property affected by exposure to noise.

According to Article 4, the municipalities shall be the authority for the application of this Law. They are responsible for exercising the duties and powers established in this Law.

Among the main duties of municipalities are:

1. Determine the standards, categories and permitted emission sources, which must be established according to the characteristics of the noise emitter and the receiving medium.

2. Establish the permitted and prohibited noise levels by regulation.

3. Establish reference techniques for sampling, measurements, analysis, evaluation of noise pollution, and for the verification and calibration of measuring instruments.

The city of Villeta does not have up-to-date regulations to the aforementioned Law, therefore, the average values specified in Law No. 1100/97 "On the Prevention of Noise Pollution" are used as a reference.

2.1.2 Law No. 1100/97 on the Prevention of Noise Pollution

The purpose of this law is to prevent noise pollution on public roads, squares, parks, promenades, performance halls, meeting centres, sports and social clubs and in all public and private activities that produce noise pollution.

According to Article No. 9, noise and annoying sounds are considered to be those that exceed the average levels specified in Table 1.

Table 1. Maximum permissible sound levels per area

Area	Night 8:00 p.m. to 7:00 a.m.	Day 07:00 to 20:00	Day (Occasional Peak) 07:00 to 12:00 14:00 to 19:00
	Measured in decibels "A"		
Residential areas for specific use, public spaces: recreational areas, parks, squares and public roads.	45	60	80
Mixed Areas, Transition Zones, Urban Centres, Specific Programmes, Service Areas and Public Buildings	55	70	85
Industrial area	60	75	90

Source: Paraguay (1997).

To compare the Leq results in dBA obtained with Law No. 1100/97, the maximum permitted values defined for the Industrial Area, highlighted in gray, were used.

Taking into account the presence of a dwelling where Point 3 of measurement was located, for the contrast of the Leq results in dBA at this point, the maximum permitted values defined for the Area corresponding to residential areas of specific use, public spaces: recreational areas, parks, squares and public roads highlighted in light blue were used.

2.1.3 Ordinance No. 25/2017 amending and updating Ordinance No. 2/94 regulating the advertising and noise nuisance system within the district of Villeta

In the district of Villeta, Law No. 1100/97 is regulated by Ordinance No. 25/2017, which amends and updates Ordinance No. 2/94, which regulates the system of advertising and nuisance noise within the district of Villeta, in accordance with the provisions of this Law.

Article 1 of this Ordinance establishes the prohibition throughout the district of Villeta of causing annoying sounds, as well as vibrations when, due to time, place or intensity, they affect the tranquility, rest, health and material goods of the population.

As for industrial installations that, located in residential areas, that make hammers or produce annoying noises, will operate within the hours of 06:00 to 12:00 and from 14:00 to 20:00 hours. Likewise, they must adopt the required devices to reduce the noise produced.

2.2 International

2.2.1 IFC/World Bank General Guidelines on Environment, Health and Safety

The IFC/World Bank MASS Guides are technical reference documents containing general and specific examples of International Good Practice for Industry. These guides contain the levels and performance indicators that can generally be achieved in new installations, with existing technology and at reasonable costs.

The guidelines state that noise impacts may not exceed the levels set out in the following Table of Noise Level Guidelines.

Table 2. Noise Level Guides

Receptor	One hour LAeq (dBA)	
	Day 07:00 – 22:00	**Night 22:00 – 07:00**
Residential, Institutional, Educational	55	45
Industrial, Commercial	70	70

Source: IFC (2007).

It should be noted that the IFC also states that the maximum increase in background noise levels can be up to 3 dB at the nearest receiver.

To contrast the Leq results in dBA obtained with the General Guidelines on Environment, Health and Safety of the International Finance Corporation, the noise level guide values defined for the Industrial Receiver highlighted in gray were used.

Taking into account the presence of a house where Point 3 of measurement was located, for the contrast of the Leq results in dBA at this point, the noise level guide values defined for the Residential, Institutional, Educational Receiver highlighted in light blue were used.

Noise monitoring shall be carried out for the purpose of establishing existing ambient noise levels in the area of proposed and existing installations, or for the purpose of checking noise levels in the operational phase.

3. MATERIALS AND METHODS

3.1 Measuring Points

The selection of the measurement points was based on the methodology proposed by Segués (2008), of directed selection of measurement points based on land uses and noise sources, which consists of previously analyzing the dynamics of the activity, land uses and establishing a zoning of the study area. On the other hand, the main sources of noise, roads, industries, sensitive areas, etc., must be analyzed.

This methodology is in accordance with the recommended method for the measurement of environmental noise in the ISO 1996-2:2017 Standard, which measures the equivalent continuous level in frequency weighting A dB(A), where they also indicate that the selection of points should be established according to the generating source.

Considering the above, Table 3 mentions the four (4) selected measurement points and their description.

Table 3. Description of Measurement Points

Point N°	Geographic Coordinates	Description of Measurement Points
1 - Main access to the property	25°42'33.6"S 57°41'56.6"W	Point of circulation of mobile emission sources, such as machinery and heavy trucks and other types of vehicles of different sizes linked to the construction and operation/maintenance stage of the project. In addition, it is a strategic point for measuring noise levels, due to its proximity to the Villeta-Alberdi Route.
2 - ATOME Property Boundary – Near Neighbor's Barn	25°42'36.7"S 57°42'09.6"W	Area close to the dwelling of the neighbors of the adjoining property, the main critical receivers of the noise levels that the industry would generate, due to the proximity of the installation of certain equipment and service areas, as well as continuous work during the construction and operation/maintenance stage, in general.
3 – Main access to the Neighbor's home	25°42'37.9"S 57°42'06.6"W	Registration point located at the main access to the neighbors' homes, they would be direct receivers of the noise levels that could occur in the different stages of the industry, which could affect their health and alter their quality of life.
4 – Future area of fixed noise sources	25°42'31.8"S 57°42'06.8"W	It corresponds to a sector of industry where emission sources such as machinery and equipment of continuous operation (mainly compressors) would be found, which could generate high noise levels, which could affect occupational and housing levels.

Figure 1 shows the location of each of the 4 selected points.

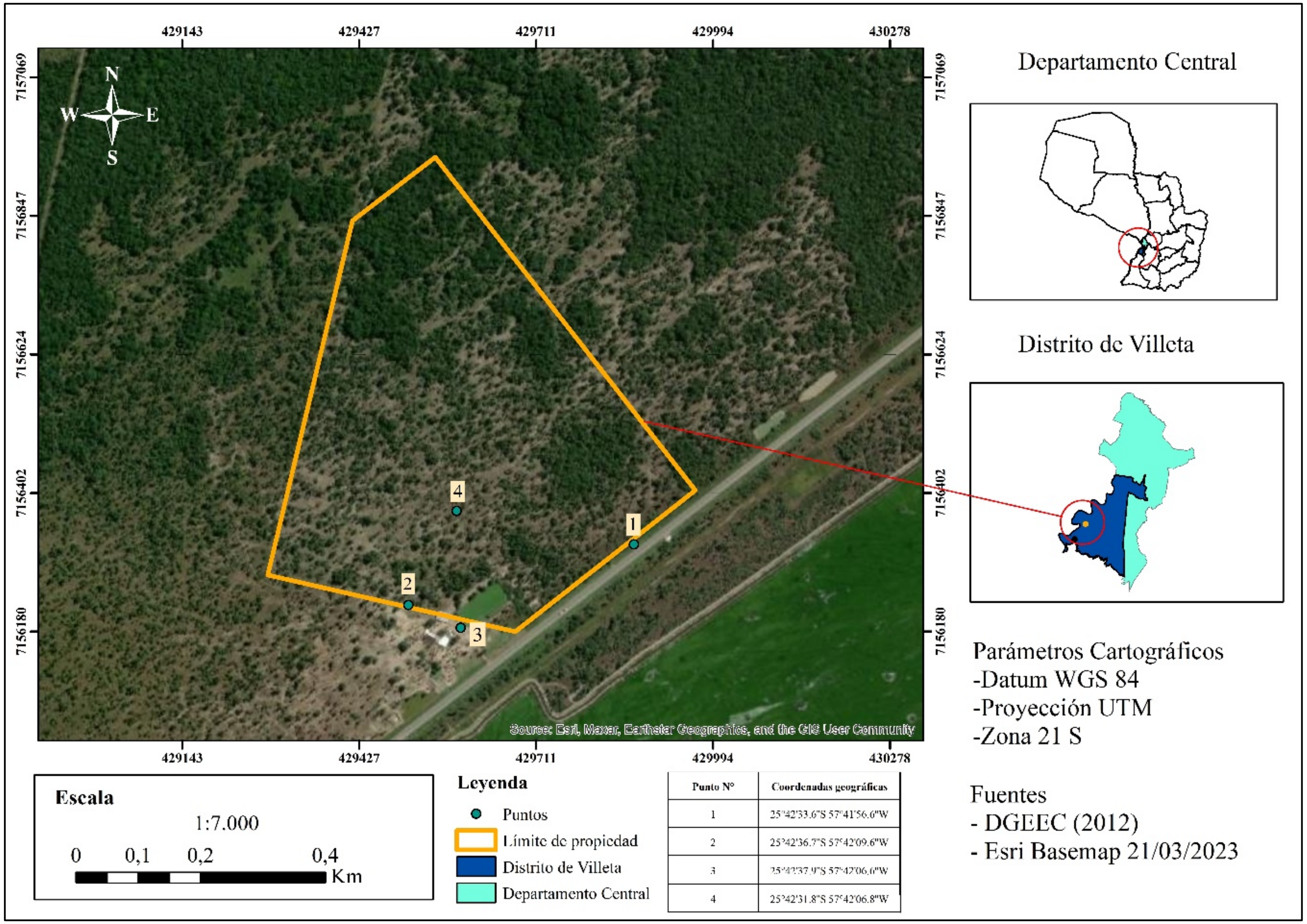


Figura 1. Localización de los puntos de medición de niveles sonoros.

3.2 Equipment

Sound level monitoring was performed with two Class 2 sound level meters that comply with IEC 61672-1 and IEC PUB 651 standards, the **PCE-322A sound level meter** and the **Minipa MSL-1355B sound level meter,** respectively**.**

Both are high-performance instruments, suitable for measuring sounds in the industrial, health, safety and environmental sectors. Both sound level meters comply with the provisions of the International Finance Corporation's General Guidelines on Environment, Health and Safety (2007): they are Type 2, frequency weighting A was used and comply with the applicable IEC standards.

The technical specifications of sound level meters are presented in Annex 8.1. Likewise, Annex 8.3 and 8.4 include the calibration certificates issued by LABSOL S.A., a calibration service provider company accredited by the National Accreditation Body (ONA), as a calibration laboratory, in accordance with the NP-ISO/IEC 17025:2018 Standard, equivalent to the ISO/IEC 17025:2017 Standard "General requirements for the competence of testing and calibration laboratories" and the requirements established in the regulations, ONA criteria and policies applicable to calibration laboratories in their current version.

3.3 Data collection

Data collection was carried out for 20 continuous hours at the 4 measurement points. The sound level meters were programmed to measure with frequency weighting A, in a range of 30 to 130 dB. The sound level meters were placed on a tripod to be placed at a distance of approximately 1.5 meters above the ground, and it was also taken into account that they are no closer than 3 meters from any reflective surface (walls, structures, obstacles), as specified in the IFC/World Bank MASS Guidelines.

According to the IFC General Guidelines on Environment, Health and Safety (2007), the usual monitoring periods should be sufficient for the statistical study and can last 48 hours with the use of noise monitoring devices that should have the ability to record data continuously during this period of time. or hourly or more frequently as deemed appropriate (or otherwise covering periods of time within multiple days, including weekdays on weekdays or over the weekend).

Due to the capacity of the Minipa MSL-1355B Sound Level Meter **Datalogger** and in order to have the largest number of records during the total measurement time, the equipment was configured in a measurement time interval of 1 data every 16 seconds, thus obtaining 4,502 records in 20 hours of measurement. As for the **PCE-322A sound level meter,** whose *Datalogger* has a larger data storage memory, yielding 1 data per second, 72,000 records were obtained in the 20 hours of measurement.

At the same time, the atmospheric variables in the weather forecast of the Directorate of Meteorology and Hydrology (DMH) were verified daily, considering the impact that climatic conditions may have on the sound measurements. A cap was used to protect the equipment from the wind and on rainy days the measurements were suspended and re-planned.

Table 4 below shows the details of the measurement schedules at each of the measurement points.

Table 4. Measurement schedules at each of the registration points.

Point N°	Measurement Start Time	End Time Measurements	Total Measurement Time
1	04:31:00	00:31:16	20 hours, 16 seconds
2	05:35:00	01:35:16	20 hours, 16 seconds
3	05:33:12	01:33:28	20 hours, 16 seconds
4	05:51:00	01:51:16	20 hours, 16 seconds

3.4 Data Processing and Analysis

3.4.1 Data Pre-Processing

Considering the differences in measurement time interval of each sound level meter, the records were pre-processed in order to standardize the amount of data between the two devices for analysis in the 20 hours of measurement at each of the 4 points. To this end, the following was done:

1) First, the data from each sound level meter were pooled every 1 hour, for the Minipa sound level meter 225 records were obtained, and for the PCE sound level meter 3,600 records were obtained.

2) Next, a simple random sampling was carried out by means of Microsoft Excel, which consists of a technique in which all the elements of a population or universe can be selected for the sample of a research. This selection process is carried out randomly or randomly, without the intervention of the researcher. This was done to randomly collect 225 recordings from the 3,600 PCE sound level meter records every hour, and thus have the same amount of data between the two sound level meters.

3.4.1 Data Processing

The data obtained by the sound level meters were processed in Microsoft Excel in order to obtain a spreadsheet with the means for each point. Due to the logarithmic nature of the sound level values, the equivalent continuous sound level (Leq) was calculated using the following formula:

Leq = 10log((Σti·10^Li/10)/T) dBA

Where:

T: This is the total duration of the measurement
Ti: is the instantaneous observation time per second
Li: Instantaneous Sound Pressure

It is important to determine the Leq value, as it represents the constant total exposure to sound levels over a period of time of interest.

The results of the Leq value measurements were calculated by specifying the frequency weight that was used (dBA), and the desired measurement time duration. For this study, it was defined to represent the Leq data every 1 hour **(LAeq1hour),** thus having 20 data for the total measurement time of 20 hours at each point.

The results were analyzed and presented in figures and tables, in such a way that the sound levels in dBA and their behavior are visualized. In this way, the temporal variability for each of the selected points is made visible.

The figures show the data on instantaneous sound levels in dB and the cumulative Leq levels in dBA, with the corresponding contrast with Law No. 1100/97 on the Prevention of Noise Pollution and the IFC/World Bank EHS Guidelines.

A sound map is also presented to achieve a graphical presentation of the behavior of sound levels in the study area.

4. RESULTS

4.1 Weather conditions

The climatic variables were obtained from the weather forecast of the Directorate of Meteorology and Hydrology (DMH). The following conditions were considered to develop the measurements:

1. Precipitation: dry weather.
2. Temperature: range above -10 °C and below 50°C.
3. Relative humidity: up to 90%.
4. Wind speed: up to 5 m/s (18 km/h). At higher wind speeds, the turbulent noise caused by the wind can mask the source of noise to be measured. However, measurements with wind speeds of up to 10 m/s (36 km/h) can be accepted. In general, wind noise peaks should be at least 10 dB below the noise source to be measured.

Table 5 shows the climatic conditions recorded every 2 hours in Villeta during the measurement days.

Table 5. Climatic conditions recorded in the city of Villeta during the measurement days.

Day	Hour	Atmospheric Variables				
		Temperature °C	*Relative humidity %*	*Velocity of the wind km/h*	*Wind Direction N, S, E, O*	*Rainfall mm*
30/09/2023	05:00	17	77	14	Sur Sur Oeste	-
	07:00	19	77	11	Sur Sur Oeste	-
	09:00	22	73	7	On	-
	11:00	25	69	5	On	-
	13:00	26	63	11	South West	-
	15:00	26	55	17	Sur Sur Oeste	-
	17:00	24	56	19	South West	-
	19:00	23	56	19	South West	-
	21:00	21	54	20	On	-
	23:00	20	63	18	On	-
	01:00	18	60	18	On	-
09/10/2023	05:00	17	85	3	South East	-
	07:00	18	80	3	South East	-
	09:00	22	68	4	On	-
	11:00	26	41	7	On	-
	13:00	29	31	9	On	-
	15:00	28	35	9	South East	-
	17:00	26	41	11	On	-
	19:00	26	41	13	South West	-
	21:00	22	40	13	On	-
	23:00	19	38	11	On	-
	01:00	18	38	11	On	-

Source: Directorate of Meteorology and Hydrology, DMH (daytime forecast).

The climatic conditions presented in the two days of measurement were suitable for recording the sound levels.

4.2 Results of LAeq1hour (dBA) sound levels in Point 1

Table 6 shows the results of the sound levels in LAeq1hour in dBA corresponding to Point 1 of measurement and their contrast with Law No. 1100/97 on the Prevention of Noise Pollution and the IFC MASS Guidelines.

The total compliance of the results obtained with the provisions of the IFC Guidelines is highlighted. With regard to compliance with Law No. 1100/97, it was also possible to verify full compliance with the schedule from 07:00 to 20:00; However, from 20:00 to 07:00 the levels were higher than what is allowed by law, except for the first time of measurement (04:31:00).

Table 6. Compliance with national and international regulations of the results of the sound levels LAeq1hour (dBA) in Point 1

Point	Timetable	Cumulative sound level LAeq1hour (dBA)	Compliance			
			Ley N° 1100/97		CFI Guides	
			07:00 to 20:00	8:00 p.m. to 7:00 a.m.	07:00 to 22:00	10:00 p.m. to 7:00 a.m.
			75 dBA	60 dBA	70 dBA	
1 – Main Access to the Property	04:31:00	57,1*		✓	✓	
	05:31:00	64,44431207		×	✓	
	06:31:00	63,0156269		×	✓	
	07:31:00	61,34709751	✓		✓	
	08:31:00	61,32018686	✓		✓	
	09:31:00	60,75769404	✓		✓	
	10:31:00	64,25489113	✓		✓	
	11:31:00	63,80845616	✓		✓	
	12:31:00	64,83809346	✓		✓	
	13:31:00	64,45128289	✓		✓	
	14:31:00	64,61098871	✓		✓	
	15:31:00	64,56975525	✓		✓	
	16:31:00	65,2993824	✓		✓	
	17:31:00	65,14630637	✓		✓	
	18:31:00	65,06028275	✓		✓	
	19:31:00	65,37374355*	✓		✓	
	20:31:00	65,33555629		×	✓	
	21:31:00	65,11980296		×	✓	
	22:31:00	64,93759659		×	✓	
	23:31:00	64,8339658		×	✓	
	00:31:16	64,71544284		×	✓	

*The maximum recorded value of LAeq1hour was 65.37 dBA; while the minimum value of LAeq1hour was 57.1 dBA.

4.2.1 Behaviour of sound levels in Point 1

Figure 2 shows the behavior of the instantaneous sound levels per second in dB recorded during the total measurement time, as well as the results obtained from LAeq1hour in dBA. In addition, the figure shows the lines that represent the maximum permitted values established in Law No. 1100/97 on the Prevention of Noise Pollution (red line) and the IFC's General Guidelines on the Environment, Health and Safety (orange line).

The highest value of instantaneous sound levels was 89.4 dB; It was produced and recorded at the exact moment that one of the tires of a medium-sized cargo truck that was traveling along the Villeta-Alberdi Route exploded. It is important to remember that Point 1 of measurement was located at the future main access of the Industrial Plant, therefore, it was very close to the aforementioned Route. This incident occurred approximately 30 meters away from where the sound level meter was located.

The other instantaneous sound levels recorded, which are in a range between 70 and 85 dB, were caused by the different mobile sources, mainly large trucks that traveled along the Route at high speeds. The circulation of heavy trucks was more frequent at night and early in the morning.

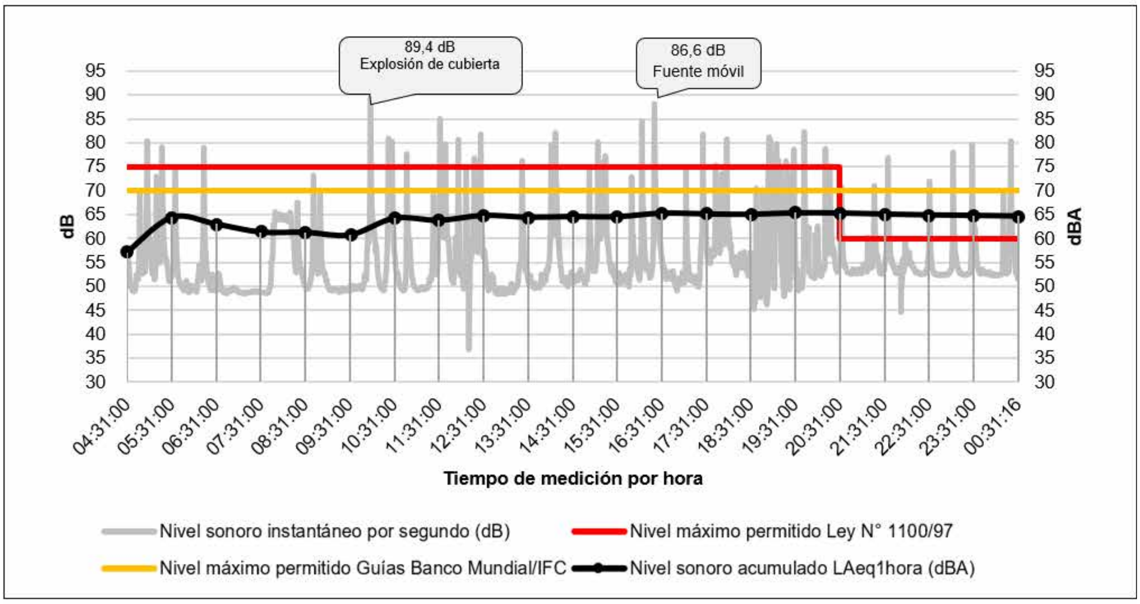


Figure 2. Behaviour of LAeq1hour (dBA) sound levels and their contrast with national and international standards in Point 1

The minimum instantaneous sound level recorded was 36.8 dB; and the average was 55.1 dB; which would be practically the levels that were maintained in the vicinity of the measurement point (in the absence of any external source, for example: mobile sources) produced by different types of insects, amphibians, birds.

LAeq1hour results remained in a range of 57.1 and 65.3 dBA during the 20 hours of measurement.

4.3 Results of sound levels LAeq1hour (dBA) in Point 2

Table 7 shows the results of the sound levels in LAeq1hour in dBA corresponding to Point 2 of measurement and their contrast with Law No. 1100/97 on the Prevention of Noise Pollution and the international requirements established in the IFC's MASS Guidelines.

The results obtained have been fully complied with in accordance with the provisions of the IFC's MASS Guidelines and Law No. 1100/97 on the prevention of noise pollution.

Table 7. Compliance with national and international regulations of the results of the sound levels LAeq1hour (dBA) in Point 2

Point	Timetable	Cumulative sound level LAeq1hour (dBA)	Compliance			
			Ley N° 1100/97		CFI Guides	
			07:00 to 20:00	8:00 p.m. to 7:00 a.m.	07:00 to 22:00	10:00 p.m. to 7:00 a.m.
			75 dBA	60 dBA	70 dBA	
2 – ATOME Property Boundary – Near Neighbor's Barn	05:35:00	58,2		✓	✓	
	06:35:00	58,24211962		✓	✓	
	07:35:00	59,62836528	✓		✓	
	08:35:00	59,95574047*	✓		✓	
	09:35:00	58,74830527	✓		✓	
	10:35:00	58,09150913	✓		✓	
	11:35:00	57,32191866	✓		✓	
	12:35:00	57,22802704	✓		✓	
	13:35:00	57,78400861	✓		✓	
	14:35:00	57,80089311	✓		✓	
	15:35:00	57,76402453	✓		✓	
	16:35:00	58,11401744	✓		✓	
	17:35:00	57,838031	✓		✓	
	18:35:00	57,60459953	✓		✓	
	19:35:00	57,64053894	✓		✓	
	20:35:00	57,36483823		✓	✓	
	21:35:00	57,18615704		✓	✓	
	22:35:00	57,15483786		✓	✓	
	23:35:00	56,92197917		✓	✓	
	00:35:00	56,69516653		✓	✓	
	01:35:16	56,62094827*		✓	✓	

*The maximum recorded value of LAeq1hour was 59.9 dBA; while the minimum value of LAeq1hour was 56.62 dBA.

4.3.1 Behaviour of sound levels in Point 2

Figure 3 shows the behavior of the instantaneous sound levels per second in dB recorded during the total measurement time, as well as the results obtained from LAeq1hour in dBA. In addition, the figure shows the lines that represent the maximum permitted values established in Law No. 1100/97 on the Prevention of Noise Pollution (red line) and the IFC MASS Guidelines (orange line).

Point 2 of measurement was located on Atome's property but close to the home of the neighbors of the adjoining property, whose activity is characterized by the breeding of various types of farm animals. It is important to remember the dynamics of the environment of the measurement point, since the highest value of instantaneous sound levels recorded was 83.6 dB; that they occurred at two times of the day, one of them in the early hours of the morning (07:17:08) which coincides exactly with the time when the horses were taken to graze, and the other in the afternoon (16:28:20) when the horses returned to the barn; The coming and going of the animals involved their passage through the vicinity of the measuring point (neighing and galloping), generating the aforementioned sound levels.

In addition, other values that exceed 70 dB could be attributed to the other animals on the farm, mainly birds such as chickens, ducks, turkeys, geese, roosters, etc., which at times also moved in the vicinity of the measurement point and that with their songs and clucks became sources of sound levels.

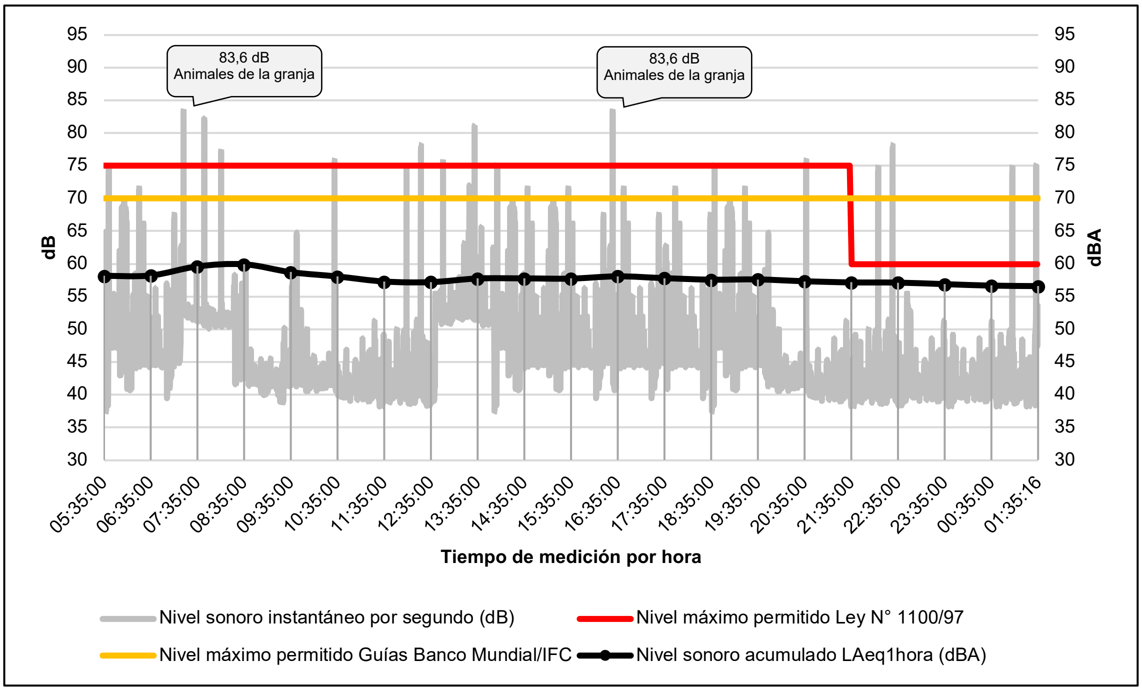


Figure 3. Behaviour of $LAeq_{1hora}$ (dBA) and its contrast with national and international regulations in Point 2

At night and early in the morning, when the farm animals were already sheltering in the barn or in the pens, the canines with their barking became sources of sound levels.

The minimum instantaneous sound level recorded was 37.4 dB; and the average yielded a value of 45.6 dB. In addition, the sounds generated by different types of insects, amphibians, and birds were a constant.

LAeq1hour results remained in a range of 56.6 and 59.9 dBA during the 20 hours of measurement.

4.3 Results of LAeq1hour (dBA) sound levels in Point 3 considering limits for Industrial Area

Table 8 shows the results of the sound levels in LAeq1hour in dBA corresponding to Point 3 of measurement and their contrast with Law No. 1100/97 on the Prevention of Noise Pollution and the international requirements established in the IFC's General Guidelines on Environment, Health and Safety for the Industrial Area.

Regarding the contrast of the results obtained with the IFC's General Guidelines on the Environment, Health and Safety, it was possible to detect in the hours of 06:33:12 and 07:33:12 values that exceed what is allowed, in the rest of the schedules values below 70 dBA were presented.

With regard to compliance with Law No. 1100/97, total compliance was observed between 07:00 and 20:00; However, from 20:00 to 07:00 the levels were higher than what is allowed by law at all times.

Table 8. Compliance with national and international regulations of the results of the sound levels LAeq1hora (dBA) in Point 3 – Industrial Area

Point	Time	Cumulative sound level $LAeq_{1hora}$ (dBA)	Compliance			
			Law No. 1100/97 on the Prevention of Noise Pollution		IFC General Environmental, Health and Safety Guidelines	
			07:00 to 20:00	20:00 to 07:00	07:00 to 22:00	22:00 to 07:00
			75 dBA	60 dBA	70 dBA	
3 – Main access to the neighbours' house	05:33:12	61,2*		×	✓	
	06:33:12	73,14897839*		×	×	
	07:33:12	71,04904653	✓		×	
	08:33:12	70,17712384	✓		✓	
	09:33:12	69,80148867	✓		✓	
	10:33:12	69,65807204	✓		✓	
	11:33:12	69,61756739	✓		✓	
	12:33:12	69,12150994	✓		✓	
	13:33:12	68,66589614	✓		✓	
	14:33:12	68,37534767	✓		✓	
	15:33:12	68,11324953	✓		✓	
	16:33:12	67,74555474	✓		✓	
	17:33:12	67,38566265	✓		✓	
	18:33:12	67,0629521	✓		✓	
	19:33:12	66,80702657	✓		✓	
	20:33:12	66,51956989		×	✓	
	21:33:12	66,25814196		×	✓	
	22:33:12	66,01255585		×	✓	
	23:33:12	65,79616673		×	✓	
	00:33:12	65,57730409		×	✓	

Point	Time	Cumulative sound level LAeq1hora (dBA)	Compliance			
			Law No. 1100/97 on the Prevention of Noise Pollution		IFC General Environmental, Health and Safety Guidelines	
			07:00 to 20:00	20:00 to 07:00	07:00 to 22:00	22:00 to 07:00
			75 dBA	60 dBA	70 dBA	
	01:33:28	65,37485103		×	✓	

*The maximum recorded value of LAeq1hour was 73.1 dBA; while the minimum value of LAeq1hour was 61.2 dBA.

4.3.1 Behaviour of sound levels in Point 3 considering limits for Industrial Area

Figure 4 shows the behavior of the instantaneous sound levels per second in dB recorded during the total measurement time, as well as the results obtained from LAeq1hour in dBA. In addition, the figure shows the lines that represent the maximum permitted values established in Law No. 1100/97 on the Prevention of Noise Pollution (red line) and the IFC's General Guidelines on the Environment, Health and Safety (orange line).

The highest noise levels were produced by the different activities related to the care and maintenance of the farm. In addition, another source that generated sound levels that was perceived from the measurement point were the mobile sources that traveled at high speeds along the Villeta-Alberdi Route.

According to the conditions in which the measurements were carried out, the possibility that a source generating sound levels from the property where the Industrial Plant would be installed could produce exposure levels that could affect the inhabitants of the house of the neighboring property is ruled out.

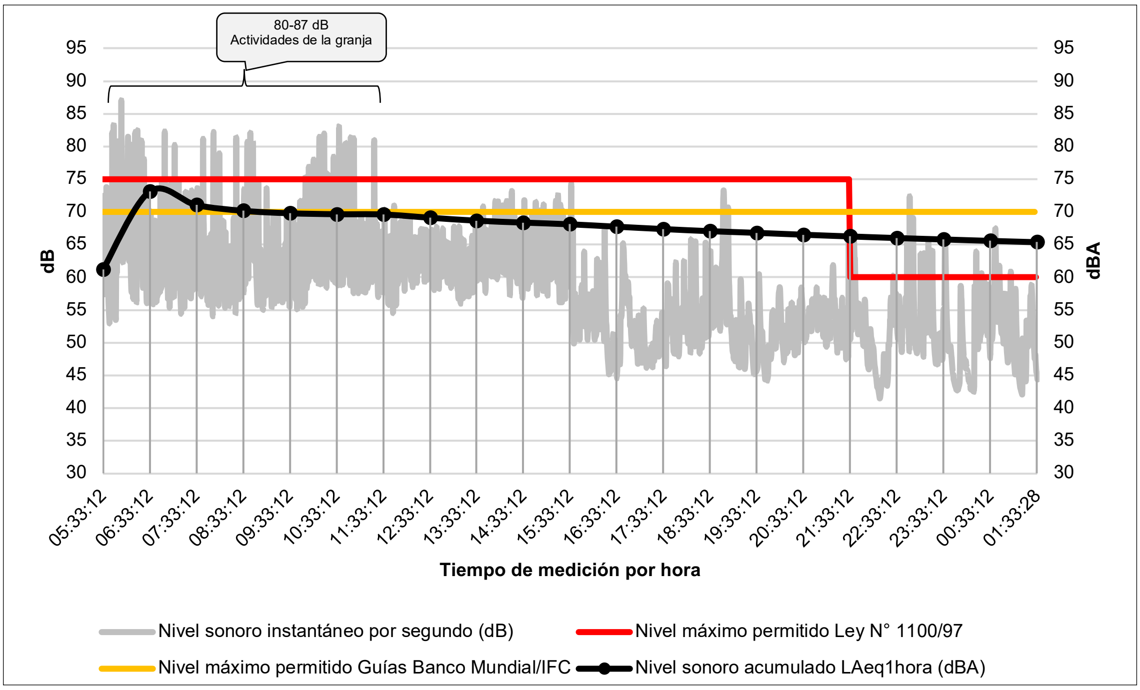


Figure 4. Behaviour of LAeq1hour (dBA) sound levels and their contrast with national and international regulations in Point 3 - Industrial Area.

The minimum instantaneous sound level recorded was 41.5 dB; and the average yielded a value of 57.7 dB.

LAeq1hour results remained in a range of 61.2 and 73.1 dBA during the 20 hours of measurement.

4.3 Results of LAeq1hour (dBA) sound levels in Point 3 considering limits for Residential Area

Table 9 shows the results of the sound levels in LAeq1hour in dBA corresponding to Point 3 of measurement and their contrast with Law No. 1100/97 on the Prevention of Noise Pollution and the international requirements established in the IFC's General Guidelines on Environment, Health and Safety for the Residential Area.

In the contrast of the LAeq1hour results in dBA with both regulations, it was found that in all cases the maximum allowed in each of the schedules is exceeded.

Table 10. Compliance with national and international regulations of the results of the sound levels LAeq1hour (dBA) in Point 3 – Residential Area

Point	**Time**	**Cumulative sound level LAeq$_{1hora}$ (dBA)**	**Compliance**			
			Law No. 1100/97 on the Prevention of Noise Pollution		**Guías Generales sobre Medio Ambiente, Salud y Seguridad de la IFC**	
			07:00 to 20:00	**20:00 a 07:00**	**07:00 a 22:00**	**22:00 a 07:00**
			60 dBA	**45 dBA**	**55 dBA**	**45 dBA**
3 – Main access to the neighbours' home	05:33:12	61,2*		×		×
	06:33:12	73,14897839*		×		×
	07:33:12	71,04904653	×		×	
	08:33:12	70,17712384	×		×	
	09:33:12	69,80148867	×		×	
	10:33:12	69,65807204	×		×	
	11:33:12	69,61756739	×		×	
	12:33:12	69,12150994	×		×	
	13:33:12	68,66589614	×		×	
	14:33:12	68,37534767	×		×	
	15:33:12	68,11324953	×		×	
	16:33:12	67,74555474	×		×	
	17:33:12	67,38566265	×		×	
	18:33:12	67,0629521	×		×	
	19:33:12	66,80702657	×		×	
	20:33:12	66,51956989		×	×	
	21:33:12	66,25814196		×	×	
	22:33:12	66,01255585		×	×	
	23:33:12	65,79616673		×		×
	00:33:12	65,57730409		×		×
	01:33:28	65,37485103		×		×

*The maximum recorded value of LAeq1hour was 73.1 dBA; while the minimum value of LAeq1hour was 61.2 dBA.

4.3.1 Behavior of sound levels in Point 3 considering limits for Residential Area

Figure 5 shows the behavior of the instantaneous sound levels per second in dB recorded during the total measurement time, as well as the results obtained from LAeq1hour in dBA. In addition, the figure shows the lines that represent the maximum permitted values established in Law No. 1100/97 on the Prevention of Noise Pollution (red line) and the IFC's General Guidelines on the Environment, Health and Safety (orange line).

The highest noise level recorded was 87 dB, produced by the different activities of the inhabitants of the house, mainly related to the care and maintenance of the farm, such as the use of wheelbarrows to transport balance bags to feed the animals, the use of edgers and weeders to clear the land and the circulation of motorcycles to access the farm. Also in the morning, during the measurements, the farm managers were observed carrying out repair activities on the zinc-coated galvanized sheet metal roof of the barn, producing sound levels due to the succession of continuous blows with the hammer through the metal.

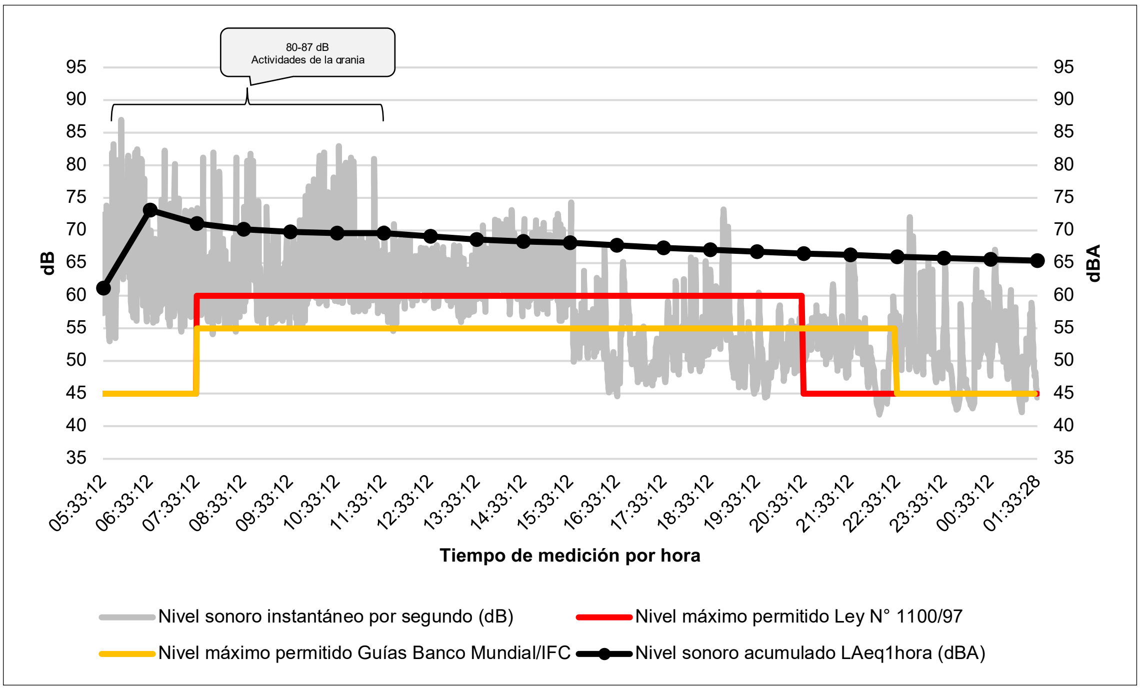


Figure 5. Behaviour of the LAeq1hour (dBA) sound levels and their contrast with national and international regulations in Point 3 – Residential Area.

Other main sources that contributed to high noise levels were the barking of the 4 canines on the farm. Other instantaneous sound level values are also related to the constant transit of different types of farm animals and their own characteristic sounds, becoming sound sources.

4.5 Results of sound levels LAeq1hour (dBA) in Point 4

Table 11 shows the results of the sound levels in LAeq1hour in dBA corresponding to Point 4 of measurement and their contrast with Law No. 1100/97 on the Prevention of Noise Pollution and the international requirements established in the IFC's General Guidelines on the Environment, Health and Safety.

The total compliance of the results obtained with the provisions of the IFC's General Guidelines on Environment, Health and Safety is highlighted.

With regard to compliance with Law No. 1100/97, it was only possible to detect at 05:51:00 a value that exceeds that allowed by law.

Table 11. Compliance with national and international regulations of the sound levels results LAeq1hora (dBA) in Point 4.

Point	Time	Cumulative noise level $LAeq_{1hora}$ (dBA)	Compliance			
			Law N° 1100/97		IFC Guidelines	
			07:00 to 20:00	20:00 to 07:00	07:00 to 22:00	22:00 to 07:00
			75 dBA	60 dBA	70 dBA	
4 – Future area of fixed noise-emitting sources	05:51:00	63,2*		×	✓	
	06:51:00	55,01006306		✓	✓	
	07:51:00	54,87408975	✓		✓	
	08:51:00	53,5705438	✓		✓	
	09:51:00	55,17344041	✓		✓	
	10:51:00	54,46582421	✓		✓	
	11:51:00	53,79619023	✓		✓	
	12:51:00	53,27662597	✓		✓	
	13:51:00	52,93351851	✓		✓	
	14:51:00	52,9336212*	✓		✓	
	15:51:00	54,59271033	✓		✓	
	16:51:00	55,78908322	✓		✓	
	17:51:00	55,87865794	✓		✓	
	18:51:00	55,80355215	✓		✓	
	19:51:00	55,64230626	✓		✓	
	20:51:00	55,45257598		✓	✓	
	21:51:00	55,25446216		✓	✓	
	22:51:00	55,05381386		✓	✓	
	23:51:00	54,97782434		✓	✓	
	00:51:00	54,96970173		✓	✓	
	01:51:16	54,84299224		✓	✓	

*The maximum recorded value of LAeq1hour was 63.2 dBA; while the minimum value of LAeq1hour was 52.9 dBA.

4.5.1 Behaviour of sound levels in Point 4

Figure 6 shows the behavior of the instantaneous sound levels per second in dB recorded during the total measurement time, as well as the results obtained from LAeq1hour in dBA. In addition, the figure shows the lines that represent the maximum permitted values established in Law No. 1100/97 on the Prevention of Noise Pollution (red line) and the IFC's General Guidelines on the Environment, Health and Safety (orange line).

The value of 80.5 dB was the highest recorded, this could be presumed to be due to an isolated case, that according to the characteristics of the site where the sound level meter was located, flocks of parrots *(Tu'i karanda'y)* were observed that could have been perched by the equipment or with their song could have become sound sources. Also, during the measurements, the presence of a fox (*Aguara'i) could be observed*, an animal characterized by its cunning and curiosity, so it could also be presumed that at some point it could have approached the measuring equipment.

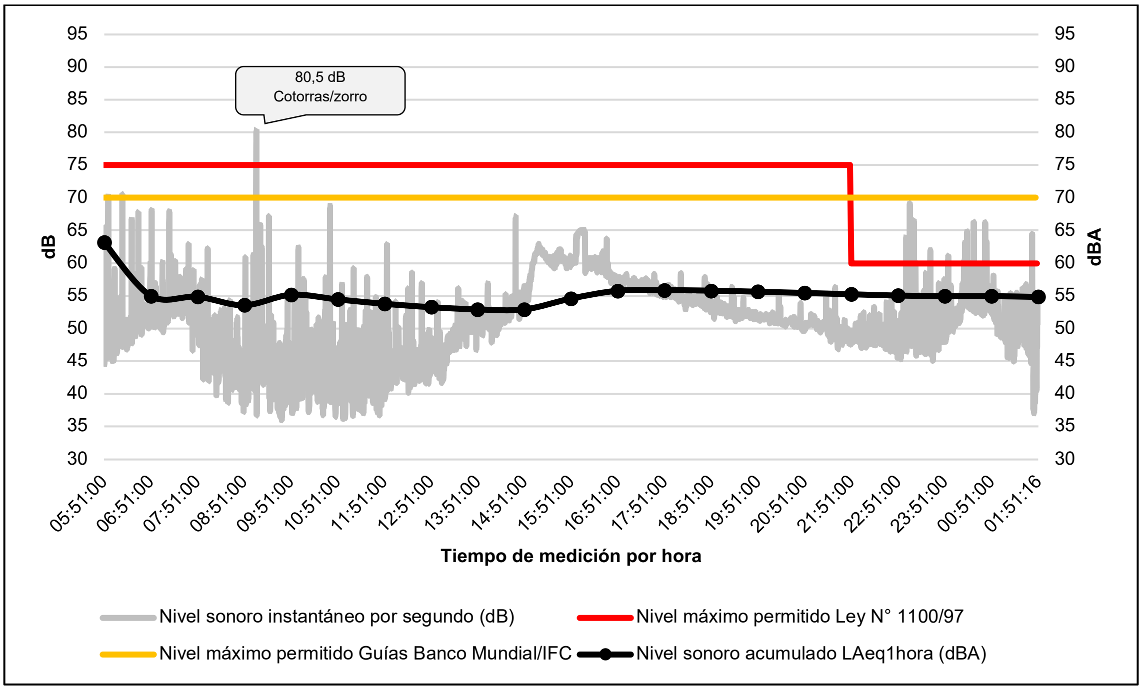


Figure 6. Behaviour of LAeq1hour (dBA) sound levels and their contrast with national and international regulations in Point 4.

The minimum instantaneous sound level recorded was 36 dB; and the average yielded a value of 50.8 dB; which would be practically the levels that were maintained in the vicinity of the measurement point (in the absence of any external source) produced by different types of insects, amphibians, birds.

The LAeq1hour results remained in a range of 52.9 and 63.2 dBA during the 20 hours of measurement.

Figure 7 shows the sound map of the behavior of the LAeq20 hours sound levels in the study area.

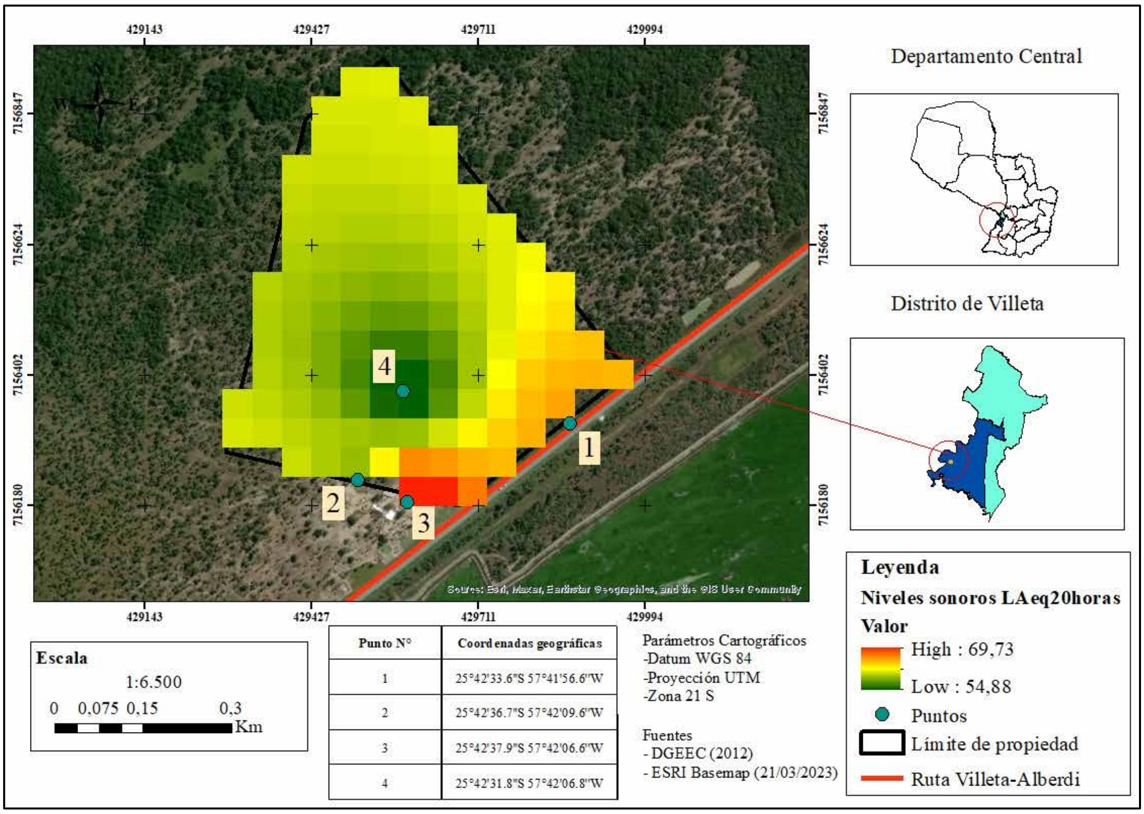


Figura 7. Sound map showing the behaviour of sound levels $LAeq_{20horas}$.

5. CONCLUSIONS

It was possible to monitor the sound levels in compliance with all the requirements established in the terms of reference provided for the consulting service.

All appropriate controls and procedures were applied to carry out the measurements of sound levels.

The peak instantaneous sound levels were maintained in a range of 80.5 and 89.4 dB between the 4 recording points during the 20 hours of measurement, which were produced by sources outside the property or by the activities of the farm adjacent to it.

Instantaneous sound levels were maintained in a range of 36 and 89.4 dB between the 4 recording points during the 20 hours of measurement

LAeq1hour levels were maintained in a range of 52.9 and 73.1 dBA between the 4 recording points during the 20 hours of measurement.

In Point 1, a level of compliance of 66.7% was recorded with reference to Law No. 1100/97 on the Prevention of Noise Pollution. The IFC's General Guidelines on Environment, Health and Safety were 100% compliant.

In Point 2, a level of compliance of 100% was recorded with reference to Law No. 1100/97 on the Prevention of Noise Pollution. The IFC's General Guidelines on Environment, Health and Safety also recorded 100% compliance.

For the analysis of Point 3 and its contrast as an Industrial Area, a level of compliance of 62% was recorded with reference to Law No. 1100/97 on the Prevention of Noise Pollution. The IFC's General Guidelines on Environment, Health and Safety were 90% compliant.

Regarding the analysis of point 3 and its contrast as a Residential Area, a level of compliance of 0% was recorded with reference to Law No. 1100/97 on the Prevention of Noise Pollution and the IFC's General Guidelines on the Environment, Health and Safety.

In Point 4, a level of compliance of 95% was recorded with reference to Law No. 1100/97 on the Prevention of Noise Pollution. The IFC's General Guidelines on Environment, Health and Safety were 100% compliant.

In general, at the 4 recording points during the 20 hours of measurement, there was a level of compliance of 81% for Law No. 1100/97 on the Prevention of Noise Pollution. The IFC's General Guidelines on Environment, Health and Safety were 98% compliant.

The results obtained will constitute a fundamental input to fulfill the purpose of the consultancy, which is to carry out the modeling of the propagation of sound levels.

6. TECHNICAL TEAM

Table 12. Technical Team

Nombre y Apellido	Función
Bruno Lovera	Environmental Technician coordinator of the measurements, field collaborator
Eng. Amb. César Fleitas Franco	Professional Technician registered by the Ministry of Labour, Employment and Social Security
Eng. Amb. Julio Bordón Gadea	Field collaborator for measurements, data processing and reporting
Osvaldo Avalos Jara	Trained field collaborator to perform the measurements

7. REFERENCES

International Finance Corporation. 2007. General Guidelines on Environment, Health and Safety. World Bank Group. 116 p

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8. ATTACHMENTS

8.1 Technical Specifications of Sound Level Meters

Table 13. Technical specifications of the PCE-322A sound level meter.

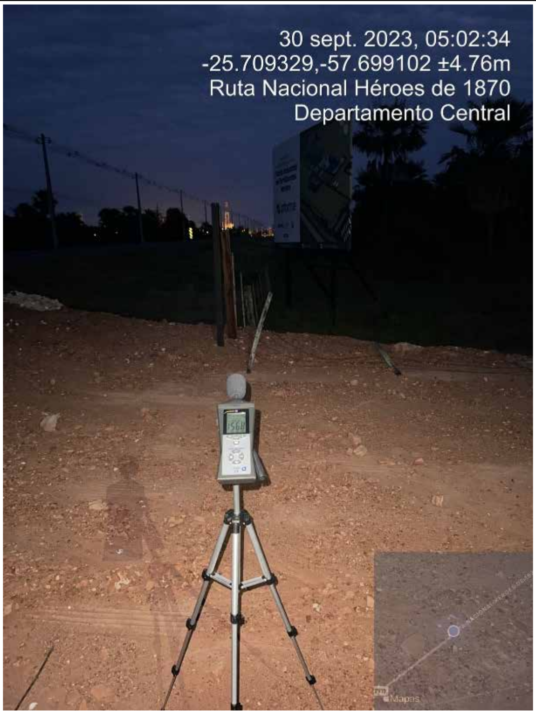
Technical Specifications		**Illustrative Image**
Measuring Ranges	Low: 30 a 80 dB	
	Medium: 50 a 100 dB	
	High: 80 a 130 dB	
	Auto: 30 a 130 dB	
Resolution	0,1 dB	
Precision	±1,4 dB	
Frequency	31,5 Hz a 8 kHz	
Memory	Approx. 32700 data + 32 GB memory card (accessory)	
Frequency Weighting	A - C	
Microphone Type	Electret Capacitor	
Functions	Values MIN, MAX, HOLD	
Operating Conditions	0 a 40 °C	
	< 90 % H.r.	
Power Source	Batery of 9 V	
Dimensions	280 x 95 x 45 mm	
Weight	Aprox. 350 g. (without batteries)	
Type	Class II	
Compliance with international standard	IEC61672-1	

Tabla 14. Technical specifications of the Minipa MSL-1355B

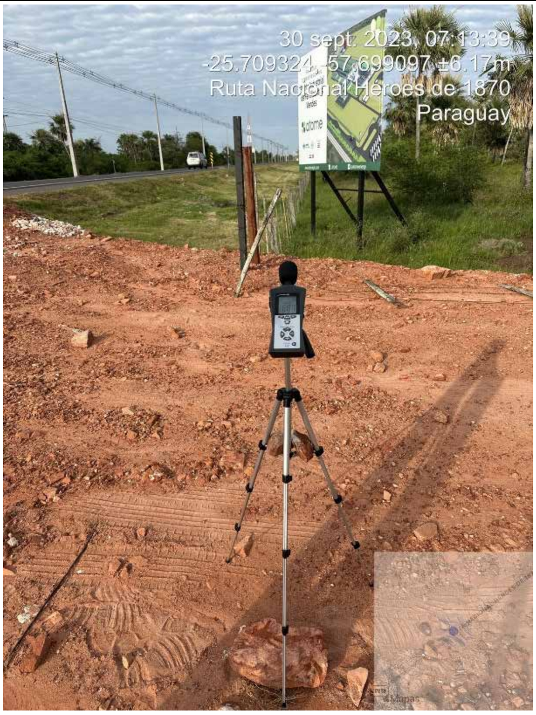
Technical Specifications		**Illustrative Image**
Resolution	0,1 dB	
Frequency Weighting	A – C	
Response Time	Fast - Slow	
Datalogger (memoria)	Approx. 4422 data points	
Datalogger Time Interval	From 1 to 250 seconds	
Battery life	Approx. 20 hours of continuous use	
Operating Conditions	0°C – 40°C	
	HR ≤ 80%	
Dimensions	256 x 70 x 35 mm	
Weight	244 g (without batteries)	
Measuring Ranges	30 a 80 dB	
	30 a 130 dB	
	50 a 100 dB	
	60 a 110 dB	
	80 a 130 dB	
Precision	±1,5 dB	
Frequency	31,5 Hz a 8,5 kHz	
Type	Class II	
Compliance with international standard	IEC PUB 651	

8.2 Photographic record of measurements

Point 1. Main access to the property



Photograph 1. Monitoring of Sound Levels in the morning hours



Photograph 2. Monitoring of Sound Levels in the morning hours

Photograph 3. Monitoring of Sound Levels at Point 1 at noon

Photograph 4. Monitoring of Sound Levels at Point 1 in the afternoon

Point 1. Main access to the property	
	
Photograph 5. Monitoring of Sound Levels at night	Photographs 5 and 6. Monitoring of Sound Levels at night

Point 2. ATOME Property Boundary – Near Neighbor's Barn

Photograph 7. Monitoring of Sound Levels in the morning hours.

Photograph 8. Monitoring of Sound Levels in the morning hours.

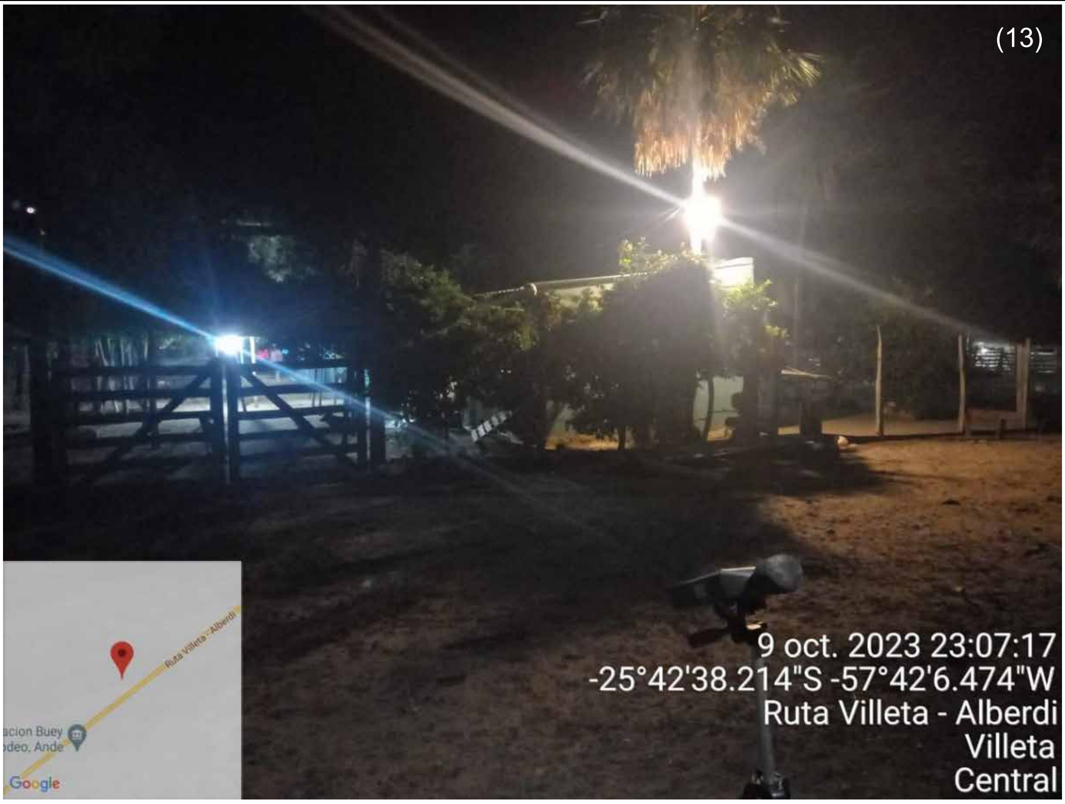
Photograph 9. Monitoring of Sound Levels in the Afternoon

Photograph 10. Monitoring of Sound Levels at night

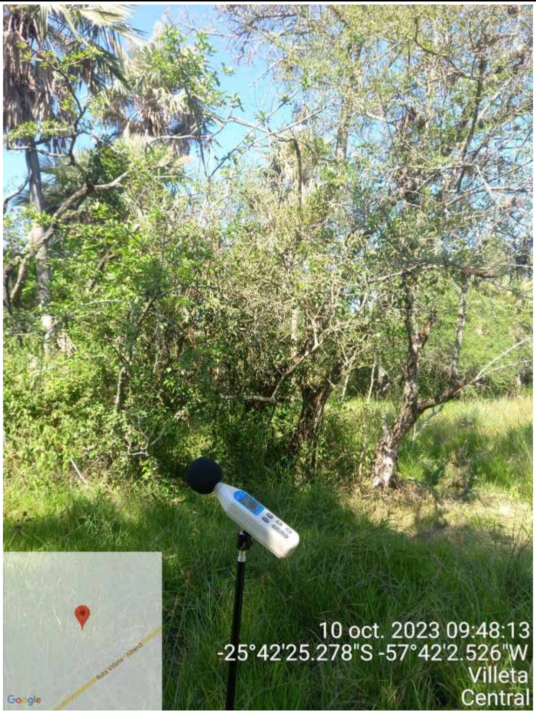
Point 3. Main access to the neighbours' house.

Photograph 11. Monitoring of Sound Levels in the morning hours

Photograph 12. Monitoring of Sound Levels in the morning hours.

Point 3. Main access to the neighbours' house.

Photographs 13 and 14. Monitoring of Sound Levels at night

Photograph 14. Monitoring of Sound Levels at night

Punto 4. Futura zona de fuentes fijas emisoras de ruido	
	
Photograph 15. Monitoring of Sound Levels at Point 4 in the morning hours	Photograph 16. Monitoring of Sound Levels at Point 4 in the morning hours
	
Photograph 17. Monitoring of Sound Levels in the morning hours	

8.3 PCE-322A Sound Level Meter Calibration Certificate

LABSOL

CERTIFICADO DE CALIBRACIÓN

Certificado N°: LS20977-2023

SERVICIO ACREDITADO

Organismo Nacional de Acreditación
NP-ISO/IEC 17025:2018
LC009

1. SOLICITANTE:	JULIO BORDON
Dirección:	Lomas Valentinas c/ Campo Via – Fdo. de la Mora
RUC:	3183136-2

2. DATOS DEL EQUIPO CALIBRADO

Instrumento:	SONOMETRO	N° de Serie:	180924367
Identificación:	SON-01	Intervalo:	(94 a 114) dB
Marca:	PCE	Resolución:	0,1 dB
Modelo:	322A	Tipo:	DIGITAL

3. PATRONES UTILIZADOS

Identificación:	PCA-01	PCT-35	---	---
Descripción:	Calibrador acústico	Termohigrometro	---	---
Certificado:	122.855	LS19107-2023	---	---
Próx. Calibración:	2024-02	2024-06	---	---

4. DATOS DE CALIBRACIÓN

Fecha de calibración:	2023-09-28
Lugar de calibración:	Laboratorio LABSOL
Temperatura:	22,6 °C
Humedad Relativa:	55 %
Procedimiento/s:	LS-PRO-C37 Rev.01

5. ABREVIATURAS

IP:	Promedio de indicacion del patrón
IEC:	Promedio de indicacion del equipo calibrado
E:	Error de medición
U:	Incertidumbre de medición
k:	Factor de cobertura

Realizado por: Tomás Duarte
Código: ID2022LS028

Autorizado por: Andrea Fernandez
Código: ID2017LS008

6. OBSERVACIONES

La incertidumbre expandida de medida informada se expresa como la incertidumbre de medida estándar multiplicado por el factor de cobertura k con una probabilidad correspondiente a aproximadamente del 95%.
La incertidumbre típica combinada fue determinada en conformidad con el documento Guía para la Expresión de la incertidumbre en las mediciones (GUM).

Firmado digitalmente por ANDREA BEATRIZ FERNANDEZ BAEZ

Este documento ha sido firmado digitalmente y tiene validez legal de acuerdo a la Ley 4017/2010

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Dirección. Tte. Jara Troche 346
Asunción, Paraguay

ADVERTENCIAS:
a) Se prohibe la reproducción de este certificado de calibración de manera parcial.
b) Los resultados presentados se refieren exclusivamente al instrumento descripto en el presente certificado.
c) Los resultados presentados se refieren a las condiciones en las que se realizaron las mediciones.

Página 1 de 2

LS-FOR-038 Rev.06
Vigencia: 2021-03-11

8.3 PCE-322A Sound Level Meter Calibration Certificate (Continued)

LABSOL

CERTIFICADO DE CALIBRACIÓN

SERVICIO ACREDITADO

Organismo Nacional de Acreditación
NP-ISO/IEC 17025:2018
LC009

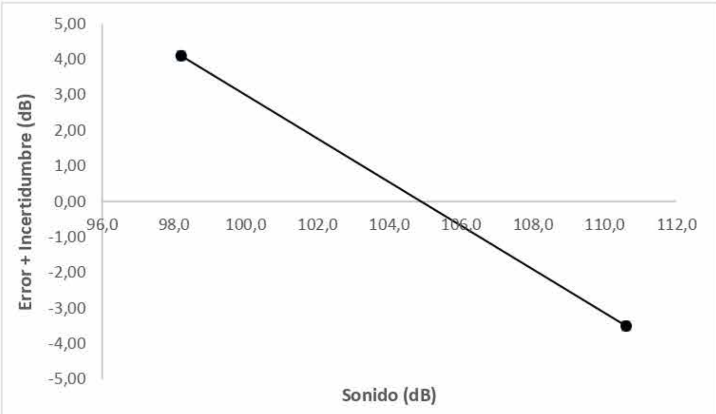
Certificado N°: LS20977-2023

7. RESULTADOS

SONIDO (dB)

IP (dB)	IEC (dB)	E (dB)	U (dB)	k
94,1	98,2	4,10	0,12	2,00
114,1	110,6	-3,50	0,12	2,00

RESULTADO GRÁFICO DE LA CALIBRACIÓN



8. FECHA DE EMISIÓN DEL CERTIFICADO: 2023-10-02

--- FIN DEL CERTIFICADO ---

Tel. +59521 202 846
E-Mail. info@labsol.com.py
Dirección. Tte. Jara Troche 346
Asunción, Paraguay

ADVERTENCIAS:
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Página 2 de 2

LS-FOR-038 Rev.06
Vigencia: 2021-03-11

8.4 Minipa MSL-1355B Sound Level Meter Calibration Certificate

LABSOL

CERTIFICADO DE CALIBRACIÓN

SERVICIO ACREDITADO

Organismo Nacional de Acreditación
NP-ISO/IEC 17025:2018
LC009

Certificado N°:	LS20702-2023

1. SOLICITANTE:	TECNOAMBIENTAL S.R.L.
Dirección:	Jose Viñuales - Fernando de La Mora
RUC:	80070966-7

2. DATOS DEL EQUIPO CALIBRADO			
Instrumento:	SONOMETRO	N° de Serie:	002182H
Identificación:	DB1	Intervalo:	(94 a 114) dB
Marca:	MINIPA	Resolución:	0,1 dB
Modelo:	MSL-1355B	Tipo:	DIGITAL

3. PATRONES UTILIZADOS				
Identificación:	PCA-01	PCT-35	---	---
Descripción:	Calibrador acústico	Termohigrometro	---	---
Certificado:	122.855	LS19107-2023	---	---
Próx. Calibración:	2024-02	2024-06	---	---

4. DATOS DE CALIBRACIÓN	
Fecha de calibración:	2023-09-08
Lugar de calibración:	Laboratorio LABSOL
Temperatura:	22,4 °C
Humedad Relativa:	83 %
Procedimiento/s:	LS-PRO-C37 Rev.00

5. ABREVIATURAS	
IP:	Promedio de indicacion del patrón
IEC:	Promedio de indicacion del equipo calibrado
E:	Error de medición
U:	Incertidumbre de medición
k:	Factor de cobertura

Realizado por: Juan Velázquez
Código: ID2023LS032

Autorizado por: Andrea Fernandez
Código: ID2017LS008

6. OBSERVACIONES

La incertidumbre expandida de medida informada se expresa como la incertidumbre de medida estándar multiplicado por el factor de cobertura k con una probabilidad correspondiente a aproximadamente del 95%.
La incertidumbre típica combinada fue determinada en conformidad con el documento Guía para la Expresión de la incertidumbre en las mediciones (GUM).

Firmado digitalmente por ANDREA BEATRIZ FERNANDEZ BAEZ

Este documento ha sido firmado digitalmente y tiene validez legal de acuerdo a la Ley 4017/2010

Tel. +59521 202 846
E-Mail. info@labsol.com.py
Dirección. Tte. Jara Troche 346
Asunción, Paraguay

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Página 1 de 2
LS-FOR-038 Rev.06
Vigencia: 2021-03-11

8.4 Minipa MSL-1355B Sound Level Meter Calibration Certificate (Continued)

LABSOL

CERTIFICADO DE CALIBRACIÓN

SERVICIO ACREDITADO

Organismo Nacional de Acreditación
NP-ISO/IEC 17025:2018
LC009

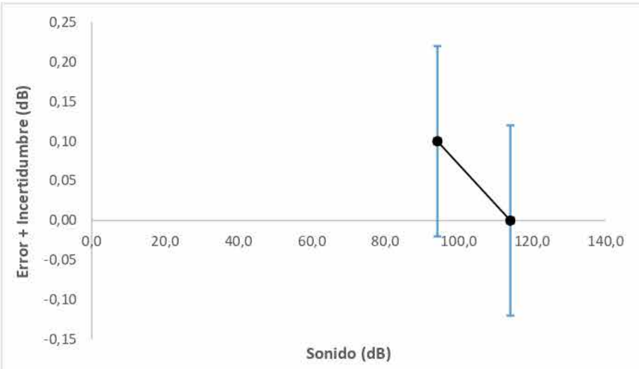
Certificado N°: LS20702-2023

7. RESULTADOS

SONIDO (dB)

IP (dB)	IEC (dB)	E (dB)	U (dB)	k
94,1	94,2	0,10	0,12	2,00
114,1	114,1	0,00	0,12	2,00

RESULTADO GRÁFICO DE LA CALIBRACIÓN



8. FECHA DE EMISIÓN DEL CERTIFICADO: 2023-09-14

--- FIN DEL CERTIFICADO ---

Tel. +59521 202 846
E-Mail. info@labsol.com.py
Dirección. Tte. Jara Troche 346
Asunción, Paraguay

ADVERTENCIAS:
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Página 2 de 2

LS-FOR-038 Rev.06
Vigencia: 2021-03-11

8.5 Technical professional register of the Ministry of Labour, Employment and Social Security of the technician in charge of the measurements

Ministerio de TRABAJO, EMPLEO Y SEGURIDAD SOCIAL — GOBIERNO NACIONAL — Paraguay de la gente

Registrado en:
Dirección de Salud y Seguridad Ocupacional
VICEMINISTERIO DE TRABAJO
Registro Profesional Técnico

Nombre Completo
CESAR AUGUSTO FLEITAS FRANCO

C.I. Nro.
2859882

Foto Carnet

Categoría
Reg. Profesional Renovación A

Fecha Registro
4/9/2023

Fecha Vencimiento
4/9/2025

Annex 7 – Flora Sampling Data Sheets

Parcel physical data sheet

Parcel N°	Vegetation Type	Date	Location	Coord. X	Coord.Y	Elevation	Soil	Comments
1	Forest	19/06/2023	Villeta, PY	429,487.0942	7,156,608.738	64 m	Clayey loam, saturated, dark, with leaf litter	Adjacent to palm savannah
2	Forest	19/06/2023	Villeta, PY	429,480.488	7,156,651.695	66 m	Clayey loam, saturated, dark, with leaf litter	Forest interior, sparse, abundant lianas
3	Forest	20/06/2023	Villeta, PY	429,537.0654	7,156,929.211	67 m	Clayey loam, saturated, dark, with leaf litter	Forest interior, sparse, abundant lianas
4	Forest	21/06/2023	Villeta, PY	429,465.3045	7,156,830.544	67 m	Clayey loam, saturated, dark, with leaf litter	Forest interior, sparse, abundant lianas
1	Savannah	18/06/2023	Villeta, PY	429,530.0186	7,156,405.563	64 m	Flooded, cattle trampling, herbaceous cover	Several species in bloom
2	Savannah	20/06/2023	Villeta, PY	429,516.5581	7,156,298.627	63 m	Flooded, cattle trampling, herbaceous cover	Several species in bloom
3	Savannah	21/06/2023	Villeta, PY	429,391.7503	7,156,465.774	65 m	Flooded, cattle trampling, herbaceous cover	Several species in bloom
4	Savannah	21/06/2023	Villeta, PY	429,629.9176	7,156,624.025	64 m	Flooded, cattle trampling, herbaceous cover	Several species in bloom
5	Savannah	21/06/2023	Villeta, PY	429,744.1344	7,156,324.829	63 m	Flooded, cattle trampling, herbaceous cover	Several species in bloom

Data of the Forest Parcels. Alt: height, DBH: diameter at breast height, Fen: phenology, EF: phytosanitary status, Obs: observations.

N°	Parcel N°	Species	Alt.	DAP	Fen.	EF	Obs.
1	1	*Copernicia alba Morong*	7.50	22.61	fruits	healthy	Lichens
2	1	*Tabebuia nodosa (Griseb.) Griseb.*	7.00	14.92	sterile	Broken branches	Lichens
3	1	*Vachellia caven (Molina) Seigler & Ebinger*	4.00	11.78	sterile	nearly dry	Few leaves
4	1	*Sorocea saxicola Hassl.*	10.00	15.45	sterile	healthy	Lichens
5	1	*Pisonia zapallo Griseb.*	8.00	13.28	sterile	healthy	Lichens
6	1	*Sorocea saxicola Hassl.*	7.20	19.11	sterile	healthy	Microgramma vaccinifolia on stem
7	1	*Parapiptadenia rigida (Benth.) Brenan*	7.00	18.60	fruits	healthy	Inclined
8	1	*Sideroxylon obtusifolium (Roem. & Schult.) T.D. Penn.*	8.50	30.60	sterile	lianas, broken branches	Tillandsia sp on stem
9	1	*Parapiptadenia rigida (Benth.) Brenan*	13.00	30.25	fruits	lianas	
10	1	*Chrysophyllum marginatum (Hook. & Arn.) Radlk. ssp. marginatum*	6.00	12.10	flowers	Broken branches	Inclined
11	1	*Eugenia uniflora L.*	5.00	10.00	sterile	healthy	Inclined
12	1	*Pisonia zapallo Griseb.*	10.00	47.16	sterile	hollow	Gills
13	1	*Pisonia zapallo Griseb.*	8.00	12.17	sterile	lianas	
14	1	*Sorocea saxicola Hassl.*	8.50	34.87	sterile	with termites	
15	1	*Sorocea saxicola Hassl.*	10.00	26.91	sterile	healthy	Microgramma vaccinifolia on stem
16	1	*Sorocea saxicola Hassl.*	7.50	16.88	sterile	healthy	Microgramma vaccinifolia on stem
17	1	*Parapiptadenia rigida (Benth.) Brenan*	14.00	29.30	fruits	parasitic, lianas	Phoradendron dipterum
18	1	*Sorocea saxicola Hassl.*	7.00	20.06	sterile	healthy	Microgramma vaccinifolia on stem
19	1	*Sorocea saxicola Hassl.*	7.00	14.97	sterile	healthy	Campylocentrum neglectum on stem
20	1	*Sorocea saxicola Hassl.*	6.80	10.19	sterile	healthy	
21	1	*Sorocea saxicola Hassl.*	8.00	17.83	sterile	healthy	C. neglectum y M. vacciniifolia on stem

JGP

atome

N°	Parcel N°	Species	Alt.	DAP	Fen.	EF	Obs.
22	1	*Pisonia zapallo Griseb.*	12.00	34.24	sterile	broken branches	
23	1	*Syagrus romanzoffiana (Cham.) Glassman*	8.00	25.96	fruits	healthy	
24	1	*Copernicia alba Morong*	8.50	20.70	fruits	cut	
25	1	*Sorocea saxicola Hassl.*	11.00	28.98	sterile	healthy	Rhipsalis baccifera on stem
26	1	*Sorocea saxicola Hassl.*	12.00	21.66	sterile	healthy	
27	1	*Pisonia zapallo Griseb.*	10.00	15.92	sterile	healthy	Lichens
28	1	*Sorocea saxicola Hassl.*	8.00	13.06	sterile	healthy	Lichens
29	1	*Sorocea saxicola Hassl.*	10.00	11.94	sterile	healthy	Lichens
30	1	*Sorocea saxicola Hassl.*	11.00	17.20	sterile	healthy	Lichens
31	1	*Chrysophyllum marginatum (Hook. & Arn.) Radlk. ssp. marginatum*	7.00	11.31	fruits	healthy	Inclined
32	1	*Plinia rivularis (Cambess.) Rotman*	5.00	13.38	sterile	broken branches	Inclined
33	1	*Plinia rivularis (Cambess.) Rotman*	4.00	11.15	sterile	healthy	Inclined
34	2	*Parapiptadenia rigida (Benth.) Brenan*	5.00	37.58	fruits	healthy	Inclined
35	2	*Libidibia paraguariensis (D. Parodi) G.P. Lewis*	13.00	45.54	sterile	with termites	Endangered
36	2	*Parapiptadenia rigida (Benth.) Brenan*	15.00	51.11	fruits	healthy	
37	2	*Sorocea saxicola Hassl.*	6.00	12.74	sterile	healthy	
38	2	*Gleditsia amorphoides (Griseb.) Taub.*	7.00	28.54	sterile	with termites	C. neglectum y M. vacciniifolia on stem
39	2	*Pisonia zapallo Griseb.*	6.70	36.62	sterile	healthy	Inclined
40	2	*Randia armata (Sw.) DC.*	3.50	10.51	sterile	healthy	Inclined
41	2	*Pisonia zapallo Griseb.*	7.00	14.01	sterile	healthy	Inclined
42	2	*Copernicia alba Morong*	10.00	23.25	fruits	healthy	
43	2	*Ruprechtia laxiflora Meisn.*	6.80	18.15	sterile	leaves eaten by insects	Microgramma vaccinifolia on stem
44	2	*Coccoloba aff. cordata Cham.*	3.80	10.19	sterile	broken branches	Inclined

N°	Parcel N°	Species	Alt.	DAP	Fen.	EF	Obs.
45	2	*Ruprechtia laxiflora Meisn.*	12.00	35.67	sterile	Leaves eaten by insects	Microgramma vaccinifolia on stem
46	2	*Parapiptadenia rigida (Benth.) Brenan*	14.00	31.53	fruits	Lianas	
47	2	*Sorocea saxicola Hassl.*	7.00	13.54	sterile	Healthy	
48	2	*Parapiptadenia rigida (Benth.) Brenan*	8.00	15.13	fruits	Lianas	
49	2	*Ruprechtia laxiflora Meisn.*	6.50	16.88	sterile	Leaves eaten by insects	
50	2	*Ruprechtia laxiflora Meisn.*	7.00	16.56	sterile	Leaves eaten by insects	
51	2	*Ruprechtia laxiflora Meisn.*	5.80	11.78	sterile	Leaves eaten by insects	
52	2	*Gleditsia amorphoides (Griseb.) Taub.*	6.00	10.83	fruits	healthy	
53	2	*Sorocea saxicola Hassl.*	5.00	10.03	sterile	lianas	
54	2	*Ruprechtia laxiflora Meisn.*	9.00	18.79	sterile	lianas	
55	2	*Ruprechtia laxiflora Meisn.*	6.50	14.89	sterile	abundant lianas	
56	2	*Sorocea saxicola Hassl.*	5.80	12.26	sterile	lianas	Campylocentrum neglectum on stem
57	2	*Pisonia zapallo Griseb.*	7.00	11.46	sterile	Healthy	Campylocentrum neglectum on stem
58	2	*Ruprechtia laxiflora Meisn.*	10.00	23.25	sterile	Healthy	
59	2	*Sideroxylon obtusifolium (Roem. & Schult.) T.D. Penn.*	14.00	27.07	sterile	Healthy	semiinclinado
60	2	*Pisonia zapallo Griseb.*	12.00	31.21	sterile	Lianas	
61	2	*Syagrus romanzoffiana (Cham.) Glassman*	9.00	17.52	sterile	Healthy	
62	2	*Eugenia uniflora L.*	5.80	12.98	sterile	Healthy	Inclined
63	2	*Eugenia uniflora L.*	6.00	12.74	sterile	Healthy	
64	2	*Eugenia uniflora L.*	6.50	14.01	sterile	Hollow	
65	2	*Eugenia uniflora L.*	5.00	10.51	sterile	Healthy	
66	3	*Indet 1*	8.50	30.57	sterile	Lianas	No leaves
67	3	*Syagrus romanzoffiana (Cham.) Glassman*	6.30	21.34	fruits	Healthy	
68	3	*Syagrus romanzoffiana (Cham.) Glassman*	2.50	11.31	fruits	Healthy	

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atome

N°	Parcel N°	Species	Alt.	DAP	Fen.	EF	Obs.
69	3	*Sideroxylon obtusifolium (Roem. & Schult.) T.D. Penn.*	6.50	18.79	sterile	Hollow	semiinclinado
70	3	*Syagrus romanzoffiana (Cham.) Glassman*	6.50	20.70	fruits	Healthy	
71	3	*Syagrus romanzoffiana (Cham.) Glassman*	5.50	14.81	sterile	Healthy	Lichens
72	3	*Chrysophyllum marginatum (Hook. & Arn.) Radlk.* ssp. *marginatum*	4.50	12.10	sterile	Healthy	
73	3	*Syagrus romanzoffiana (Cham.) Glassman*	3.50	10.83	sterile	Healthy	Lichens
74	3	*Parapiptadenia rigida (Benth.) Brenan*	7.80	14.97	fruits	Healthy	Peperomia aceroana on stem
75	3	*Syagrus romanzoffiana (Cham.) Glassman*	4.00	22.61	sterile	Healthy	Lichens
76	3	*Eugenia uniflora L.*	4.00	11.94	sterile	with termites	
77	3	*Sorocea saxicola Hassl.*	6.00	14.65	sterile	healthy	Lichens
78	3	*Indet 2 Fabaceae*	8.00	20.76	sterile	hollow	Few leaves
79	3	*Zanthoxylum fagara (L.) Sarg*. ssp. *fagara*	6.00	15.92	sterile	Healthy	Lichens
80	3	*Indet 1*	8.00	29.30	sterile	lianas	Few leaves
81	3	*Schinopsis balansae Engl.*	14.00	47.77	sterile	Healthy	Lichens
82	3	*Sideroxylon obtusifolium (Roem. & Schult.) T.D. Penn.*	6.00	10.51	sterile	Healthy	
83	3	*Gleditsia amorphoides (Griseb.) Taub.*	5.00	14.97	sterile	Holloe	Lichens
84	3	*Syagrus romanzoffiana (Cham.) Glassman*	4.00	19.11	sterile	Healthy	
85	4	*Tabebuia nodosa (Griseb.) Griseb.*	9.00	24.20	sterile	Healthy	C. neglectum y M. vacciniifolia on stem
86	4	*Cordia americana (L.) Gottschling & J.S. Mill.*	10.00	18.63	sterile	Healthy	Trichocentrum pumilum on stem
87	4	*Ruprechtia laxiflora Meisn.*	7.80	13.38	sterile	Healthy	P. aceroana y M. vacciniifolia on stem
88	4	*Ruprechtia laxiflora Meisn.*	8.00	18.15	sterile	lianas	Microgramma vaccinifolia on stem
89	4	*Casearia* sp	6.00	13.69	sterile	abundant lianas	
90	4	*Parapiptadenia rigida (Benth.) Brenan*	6.50	23.57	fruits	Broken branches	
91	4	*Cordia americana (L.) Gottschling & J.S. Mill.*	10.00	29.46	sterile	lianas	Semi-inclined
92	4	*Indet 3 Myrtaceae*	7.00	22.93	sterile	lianas	Rhipsalis lumbricoides on stem
93	4	*Indet 3 Myrtaceae*	6.50	10.51	sterile	lianas	Microgramma vaccinifolia on stem

JGP

atome

N°	Parcel N°	Species	Alt.	DAP	Fen.	EF	Obs.
94	4	*Peltophorum dubium (Spreng.) Taub.*	11.00	26.11	fruits	lianas	Trichocentrum pumilum on stem
95	4	*Machaerium sp*	7.00	25.80	sterile	lianas	Rhipsalis lumbricoides on stem
96	4	*Ruprechtia laxiflora Meisn.*	8.50	17.09	sterile	Broken branches	Microgramma vaccinifolia on stem
97	4	*Indet 3 Myrtaceae*	6.00	19.75	sterile	abundant lianas, hollow	
98	4	*Guazuma ulmifolia Lam.*	5.70	18.15	fruits	lianas	
99	4	*Syagrus romanzoffiana (Cham.) Glassman*	4.80	11.15	sterile	Healthy	
100	4	*Chrysophyllum marginatum (Hook. & Arn.) Radlk.* ssp. *marginatum*	3.50	10.83	sterile	lianas	Inclined stem, with Microgramma vacciniifolia
101	4	*Schinopsis balansae Engl.*	10.00	28.03	sterile	lianas	Semi-inclined
102	4	*Schinopsis balansae Engl.*	9.00	21.97	sterile	Abundant lianas	
103	4	*Syagrus romanzoffiana (Cham.) Glassman*	3.80	14.01	sterile	Healthy	
104	4	*Chrysophyllum marginatum (Hook. & Arn.) Radlk.* ssp. *marginatum*	7.00	17.52	sterile	lianas	Inclined stem, with Microgramma vacciniifolia

Data of the Savannah Parcels

N°	Parcel N°	Family	Species	Habit	Comments
1	1	Cyperaceae	*Eleocharis elegans (Kunth) Roem. & Schult.*	Grass	aquatic-palustrine
2	1	Cyperaceae	*Eleocharis filiculmis Kunth Kunth*	Grass	aquatic-palustrine
3	1	Cyperaceae	*Cyperus entrerianus Boeck. var. entrerianus*	Grass	palustrine
4	1	Poaceae	*Setaria* sp	Grass	palustrine
5	1	Lythraceae	*Cuphea* sp1	Grass	esterile
6	1	Poaceae	*Panicum* sp	Grass	palustrine
7	1	Onagraceae	*Ludwigia decurrens Walter*	Subshrub	palustrine
8	1	Cyperaceae	*Cyperus odoratus L.*	Grass	aquatic-palustrine
9	1	Poaceae	*Hymenachne amplexicaulis (Rudge) Nees*	Grass	aquatic
10	1	Euphorbiaceae	*Caperonia castaneifolia (L.) A. St.-Hil.*	Grass	palustrine
11	1	Euphorbiaceae	*Caperonia palustris (L.) A. St.-Hil.*	Grass	palustrine
12	1	Oxalidaceae	*Oxalis paludosa A. St.-Hil.*	Grass	palustrine
13	1	Solanaceae	*Solanum glaucophyllum Desf.*	Subshrub	palustrine
14	1	Arecaceae	*Copernicia alba Morong*	Palm	palustrine
15	1	Cyperaceae	*Cyperus sesquiflorus (Torr.) Mattf. & Kük. ex Kük.*	Grass	palustrine, medicinal
16	1	Poaceae	*Echinochloa colona (L.) Link*	Grass	adventitia
17	1	Pontederiaceae	*Pontederia cordata L. var. cordata*	Grass	aquatic
18	1	Cyperaceae	*Rhynchospora* sp	Grass	palustrine
19	1	Asteraceae	*Eclipta prostata (L.) L.*	Grass	palustrine
20	1	Convolvulaceae	*Ipomoea* sp1	Grass	rambler, esterile
21	1	Fabaceae	*Sesbania virgata (Cav.) Poir.*	Shrub	palustrine
22	1	Asteraceae	*indet 1*	Grass	esterile
23	1	Phyllanthaceae	*Moeroris stipulata Raf.*	Grass	Palustrine
24	1	Asteraceae	*Pterocaulon virgatum (L.) DC.*	Grass	ruderal, palustrine, medicinal

N°	Parcel N°	Family	Species	Habit	Comments
25	1	Amaranthaceae	*Pfaffia glomerata (Spreng.) Pedersen*	Grass	palustrine, medicinal
26	1	Fabaceae	*Vachellia caven (Molina) Seigler & Ebinger*	Shrub	palustrine, medicinal
27	1	Passifloraceae	*Passiflora misera Kunth misera Kunth*	Grass	rambler, esterile
28	1	Fabaceae	*Mimosa debilis Humb. & Bonpl. ex Willd. var. debilis*	Grass	creeper
29	1	Malvaceae	*Sida aff. potentilloides A. St.-Hil.*	Subshrub	in less waterlogged areas
30	2	Fabaceae	*Sesbania virgata (Cav.) Poir.*	Shrub	palustrine
31	2	Cyperaceae	*Eleocharis elegans (Kunth) Roem. & Schult.*	Grass	palustrine
32	2	Cyperaceae	*Cyperus entrerianus Boeck. var. entrerianus*	Grass	palustrine
33	2	Poaceae	*Leersia hexandra Sw.*	Grass	palustrine
34	2	Poaceae	*Hymenachne amplexicaulis (Rudge) Nees*	Grass	aquatic
35	2	Oxalidaceae	*Oxalis paludosa A. St.-Hil.*	Grass	palustrine
36	2	Poaceae	*Paspalum* sp2	Grass	palustrine
37	2	Asteraceae	*Eupatorium* sp1	Grass	esterile
38	2	Euphorbiaceae	*Caperonia castaneifolia (L.) A. St.-Hil.*	Grass	palustrine
39	2	Phyllanthaceae	*Moeroris stipulata Raf.*	Grass	palustrine
40	2	Cyperaceae	*Eleocharis filiculmis Kunth Kunth*	Grass	palustrine
41	2	Araliaceae	*Hydrocotyle ranunculoides L. f.*	Grass	aquatic-palustrine
42	2	Plantaginaceae	*Bacopa salzmannii (Benth.) Wettst. ex Edwall*	Grass	palustrine
43	2	Apocynaceae	*Mandevilla angustifolia (Malme) Woodson*	Grass	rambler, esterile
44	2	Cyperaceae	*Rhynchospora* sp	Grass	palustrine
45	2	Malvaceae	*Pavonia* sp	Grass	in less waterlogged areas
46	2	Commelinaceae	*Commelina erecta L.*	Grass	ruderal, medicinal
47	2	Onagraceae	*Ludwigia decurrens Walter*	Subshrub	palustrine
48	2	Cyperaceae	*Cyperus odoratus L.*	Grass	palustrine
49	2	Asteraceae	*Eclipta prostata (L.) L.*	Grass	palustrine
50	2	Orobanchaceae	*Agalinis genistifolia (Cham. & Schltdl.) D'Arcy*	Grass	palustrine

N°	Parcel N°	Family	Species	Habit	Comments
51	2	Orobanchaceae	*Agalinis communis (Cham. & Schltdl.) D'Arcy*	Grass	palustrine
52	2	Apiaceae	*Eryngium elegans Cham. & Schltdl.*	Grass	palustrine, medicinal
53	2	Fabaceae	*Mimosa balansae Micheli*	Grass	in less waterlogged areas
54	2	Convolvulaceae	*Ipomoea* sp2	Grass	trepadora, esterile
55	2	Asteraceae	*indet 2*	Grass	Esterile
56	2	Malvaceae	*Sidastrum paniculatum (L.) Fryxell*	Grass	in less waterlogged areas
57	2	Malvaceae	*Sida spinosa L.*	Grass	ruderal, medicinal
58	2	Poaceae	*Setaria* sp	Grass	palustrine
59	2	Solanaceae	*Solanum glaucophyllum Desf.*	Subshrub	palustrine
60	2	Convolvulaceae	*Ipomoea carnea Jacq. subsp. fistulosa (Mart. ex Choisy). D.F. Austin*	Shrub	palustrine
61	2	Asteraceae	*Chromolaena laevigata (Lam.) R.M. King & H. Rob. var. laevigata*	Shrub	in less waterlogged areas
62	2	Amaranthaceae	*Alternanthera kurtzii Schinz ex Pedersen* ssp. *kurtzii*	Grass	palustrine
63	2	Malvaceae	*Hibiscus* sp	Grass	Esterile
64	2	Asteraceae	*indet 3*	Subshrub	with flower buds
65	2	Plantaginaceae	*Mecardonia procumbens (Mill.) Small var. flagellaris (Cham. & Schltdl.) V.C. Souza*	Grass	wet areas and roadsides
66	2	Arecaceae	*Copernicia alba Morong*	Palm	regeneration, food use, craft
67	2	Lythraceae	*Cuphea racemosa (L. f.) Spreng.* ssp. *racemosa*	Grass	ruderal, medicinal
68	2	Pontederiaceae	*Pontederia cordata L. var. cordata*	Grass	aquatic-palustrine
69	2	Poaceae	*Panicum* sp	Grass	palustrine
70	3	Arecaceae	*Copernicia alba Morong*	Palm	palustrine, alimenticio, uso artesanal
71	3	Poaceae	*Setaria* sp	Grass	dried fruit
72	3	Malvaceae	*Pavonia* sp	Grass	in less waterlogged areas
73	3	Onagraceae	*Ludwigia decurrens Walter*	Subshrub	palustrine
74	3	Cyperaceae	*Cyperus entrerianus Boeck. var. entrerianus*	Grass	palustrine
75	3	Poaceae	*Paspalum* sp2	Grass	palustrine

N°	Parcel N°	Family	Species	Habit	Comments
76	3	Poaceae	*Leersia hexandra Sw.*	Grass	palustrine
77	3	Menyanthaceae	*Nymphoides indica (L.) Kuntze*	Grass	aquatic
78	3	Oxalidaceae	*Oxalis paludosa A. St.-Hil.*	Grass	palustrine
79	3	Cyperaceae	*Eleocharis elegans (Kunth) Roem. & Schult.*	Grass	palustrine
80	3	Poaceae	*Hymenachne amplexicaulis (Rudge) Nees*	Grass	aquatic
81	3	Phyllanthaceae	*Moeroris stipulata Raf.*	Grass	palustrine
82	3	Poaceae	*Panicum* sp	Grass	palustrine
83	3	Pontederiaceae	*Pontederia cordata L. var. cordata*	Grass	aquatic
84	3	Araliaceae	*Hydrocotyle ranunculoides L. f.*	Grass	aquatic-palustrine
85	3	Asteraceae	*Eclipta prostata (L.) L.*	Grass	palustrine
86	3	Malvaceae	*Sida spinosa L.*	Grass	ruderal, medicinal
87	3	Solanaceae	*Solanum glaucophyllum Desf.*	Subshrub	palustrine
88	3	Commelinaceae	*Commelina erecta L.*	Grass	ruderal, medicinal
89	3	Asteraceae	*Eupatorium* sp1	Grass	Esterile
90	3	Fabaceae	*Macroptilium erythroloma (Mart. ex Benth.) Urb.*	Grass	Rambler
91	3	Lythraceae	*Cuphea lysimachioides Cham. & Schltdl.*	Grass	ruderal
92	3	Malvaceae	*Sidastrum paniculatum (L.) Fryxell*	Grass	In less waterlogged areas
93	3	Asteraceae	*Pterocaulon virgatum (L.) DC.*	Grass	ruderal, palustrine
94	3	Cyperaceae	*Rhynchospora* sp	Grass	palustrine
95	3	Orobanchaceae	*Agalinis genistifolia (Cham. & Schltdl.) D'Arcy*	Grass	palustrine
96	3	Alismataceae	*Helanthium* sp	Grass	palustrine
97	3	Cyperaceae	*Cyperus odoratus L.*	Grass	palustrine
98	3	Solanaceae	*Jaborosa integrifolia Lam.*	Grass	palustrine
99	3	Fabaceae	*Vachellia caven (Molina) Seigler & Ebinger*	Shrub	palustrine, medicinal
100	3	Bromeliaceae	*Tillandsia recurvifolia Hook.*	Grass	epiphyte, Vachellia caven on stem
101	3	Amaranthaceae	*Pfaffia glomerata (Spreng.) Pedersen*	Grass	palustrine, medicinal
102	4	Arecaceae	*Copernicia alba Morong*	Palm	palustrine, edible, craft use

N°	Parcel N°	Family	Species	Habit	Comments
103	4	Salicaceae	*Xylosma venosum N.E.Brown.*	Shrub	palustrine
104	4	Poaceae	*Panicum* sp	Grass	palustrine
105	4	Fabaceae	*Mimosa* sp	Grass	esterile
106	4	Oxalidaceae	*Oxalis paludosa A. St.-Hil.*	Grass	palustrine
107	4	Onagraceae	*Ludwigia decurrens Walter*	Subshrub	palustrine
108	4	Cyperaceae	*Cyperus entrerianus Boeck. var. entrerianus*	Grass	palustrine
109	4	Cyperaceae	*Eleocharis elegans (Kunth) Roem. & Schult.*	Grass	palustrine
110	4	Pontederiaceae	*Pontederia cordata L. var. cordata*	Grass	aquatic-palustrine
111	4	Cyperaceae	*Cyperus odoratus L.*	Grass	palustrine
112	4	Araliaceae	*Hydrocotyle ranunculoides L. f.*	Grass	aquatic-palustrine
113	4	Asteraceae	*Eclipta prostata (L.) L.*	Grass	palustrine
114	4	Cyperaceae	*Cyperus aff. digitatus Roxb.*	Grass	palustrine
115	4	Poaceae	*Paspalum* sp2	Grass	palustrine
116	4	Orobanchaceae	*Agalinis genistifolia (Cham. & Schltdl.) D'Arcy*	Grass	palustrine
117	4	Menyanthaceae	*Nymphoides indica (L.) Kuntze*	Grass	aquatic
118	4	Plantaginaceae	*Bacopa salzmannii (Benth.) Wettst. ex Edwall*	Grass	palustrine
119	4	Poaceae	*Hymenachne amplexicaulis (Rudge) Nees*	Grass	acuática
120	5	Arecaceae	*Copernicia alba Morong*	Palm	palustrine
121	5	Poaceae	*Paspalum* sp2	Grass	palustrine
122	5	Poaceae	*Lasiacis* sp	Grass	palustrine
123	5	Oxalidaceae	*Oxalis paludosa A. St.-Hil.*	Grass	palustrine
124	5	Poaceae	*Leersia hexandra Sw.*	Grass	palustrine
125	5	Asteraceae	*Eclipta prostata (L.) L.*	Grass	palustrine
126	5	Cyperaceae	*Cyperus entrerianus Boeck. var. entrerianus*	Grass	palustrine
127	5	Cyperaceae	*Cyperus aff. digitatus Roxb.*	Grass	palustrine
128	5	Fabaceae	*Aeschynomene* sp	Grass	palustrine

N°	Parcel N°	Family	Species	Habit	Comments
129	5	Poaceae	*Paspalum* sp1	Grass	palustrine
130	5	Commelinaceae	*Commelina erecta L.*	Grass	ruderal, medicinal
131	5	Fabaceae	*Vachellia caven (Molina) Seigler & Ebinger*	Shrub	palustrine, medicinal
132	5	Bromeliaceae	*Tillandsia recurvifolia Hook.*	Grass	epiphyte, Vachellia caven on stem
133	5	Polygonaceae	*Muehlenbeckia sagittifolia (Ortega) Meisn.*	Grass	rambler, medicinal
134	5	Convolvulaceae	*Ipomoea carnea Jacq. subsp. fistulosa (Mart. ex Choisy). D.F. Austin*	Shrub	palustrine
135	5	Fabaceae	*Senna pendula (Willd.) H.S. Irwin & Barneby var. paludicola H.S. Irwin & Barneby*	Shrub	palustrine
136	5	Cyperaceae	*Eleocharis elegans (Kunth) Roem. & Schult.*	Grass	palustrine
137	5	Bignoniaceae	*Tabebuia nodosa (Griseb.) Griseb.*	Tree	In les waterlogged areas
138	5	Lythraceae	*Cuphea* sp2	Grass	esterile
139	5	Vitaceae	*Cissus palmata Poir.*	Subshrub	rambler, on Tabebuia nodosa
140	5	Cyperaceae	*Eleocharis filiculmis Kunth Kunth*	Grass	palustrine
141	5	Alismataceae	*Helanthium* sp	Grass	palustrine
142	5	Malvaceae	*Pavonia* sp	Grass	Esterile
143	5	Asteraceae	*indet 4*	Subshrub	esterile
144	5	Asteraceae	*Eupatorium* sp2	Subshrub	Dried fruits
145	5	Asteraceae	*Vernonia* sp	Grass	Flower buds
146	5	Orobanchaceae	*Agalinis genistifolia (Cham. & Schltdl.) D'Arcy*	Grass	palustrine
147	5	Pontederiaceae	*Pontederia cordata L. var. cordata*	Grass	aquatic - palustrine

Annex 8 – List of Flora Species

Table 5.3.1.3.2.a
List of species recorded during the second survey

N°	Family	Species	Common name
1	Anacardiaceae	*Schinopsis balansae* Engl.	Quebracho colorado
2	Arecaceae	*Copernicia alba* Morong	Karanda'y
3	Arecaceae	*Syagrus romanzoffiana* (Cham.) Glassman	Pindo
4	Bignoniaceae	*Tabebuia nodosa* (Griseb.) Griseb.	Labón
5	Boraginaceae	*Cordia americana* (L.) Gottschling & J.S. Mill.	Guajayvi
6	Fabaceae	*Gleditsia amorphoides* (Griseb.) Taub.	Yvope
7	Fabaceae	Indet 2	
8	Fabaceae	*Libidibia paraguariensis* (D. Parodi) G.P. Lewis	Guayacán
9	Fabaceae	*Machaerium* sp	
10	Fabaceae	*Parapiptadenia rigida* (Benth.) Brenan	Kurupa'yrâ
11	Fabaceae	*Peltophorum dubium* (Spreng.) Taub.	Yvyra pytâ
12	Fabaceae	*Vachellia caven* (Molina) Seigler & Ebinger	Aromita
13	Undetermined	Indet 1	
14	Malvaceae	*Guazuma ulmifolia* Lam.	Kamba akâ
15	Moraceae	*Sorocea saxicola* Hassl.	Ñandypami
16	Myrtaceae	*Eugenia uniflora* L.	Ñangapiry
17	Myrtaceae	Indet 3	
18	Myrtaceae	*Plinia rivularis* (Cambess.) Rotman	Yvaporoity
19	Nyctaginaceae	*Pisonia Griseb Pumpkin* .	Jukyryvusu
20	Polygonaceae	*Coccoloba* aff. *cordata* Cham.	Duraznillo moado
21	Polygonaceae	*Ruprechtia laxiflora* Meisn.	Yvyra pytâ'i
22	Rubiaceae	*Randia armata* (Sw.) DC.	Ñuatî kurusu
23	Rutaceae	*Zanthoxylum fagara* (L.) Sarg. ssp. *Fagara*	Mbarakaja pyâpe
24	Salicaceae	Casearia sp	
25	Sapotaceae	*Chrysophyllum marginatum* (Hook. & Arn.) Radlk. ssp. *marginatum*	Pykasu rembi'u
26	Sapotaceae	*Sideroxylon obtusifolium* (Roem. & Schult.) T.D. Penn.	Guajayvirai

Table 5.3.1.3.2.b
Distribution of species in the second survey

Species	Variance	Stocking	Probability	Distribution
Schinopsis balansae Engl.	0.92	0.75	0.30	random
Copernicia alba Morong	0.92	0.75	0.30	random
Syagrus romanzoffiana (Cham.) Glassman	8.25	2.75	0.03	random
Tabebuia nodosa (Griseb.) Griseb.	0.33	0.50	0.58	random
Cordia americana (L.) Gottschling & J.S. Mill.	1.00	0.50	0.11	random
Gleditsia amorphoides (Griseb.) Taub.	0.92	0.75	0.30	random
Indet 2	0.25	0.25	0.39	random
Libidibia paraguariensis (D. Parodi) G.P. Lewis	0.25	0.25	0.39	random
Machaerium sp	0.25	0.25	0.39	random
Parapiptadenia rigida (Benth.) Brenan	2.25	2.25	0.39	random
Peltophorum dubium (Spreng.) Taub.	0.25	0.25	0.39	random
Vachellia caven (Molina) Seigler & Ebinger	0.25	0.25	0.39	random
Indet 1	1.00	0.50	0.11	random
Guazuma ulmifolia Lam.	0.25	0.25	0.39	random

Table 5.3.1.3.2.b
Distribution of species in the second survey

Species	Variance	Stocking	Probability	Distribution
Sorocea saxicola Hassl.	40.92	4.75	0.00	aggregate
Eugenia uniflora L.	3.00	1.50	0.11	random
Indet 3	2.25	0.75	0.03	random
Plinia rivularis (Cambess.) Rotman	1.00	0.50	0.11	random
Pisonia Griseb Pumpkin .	6.92	2.25	0.03	random
Coccoloba aff. *cordata* Cham.	0.25	0.25	0.39	random
Ruprechtia laxiflora Meisn.	14.25	2.75	0.00	aggregate
Randia armata (Sw.) DC.	0.25	0.25	0.39	random
Zanthoxylum fagara (L.) Sarg. ssp. *Fagara*	0.25	0.25	0.39	random
Casearia sp	0.25	0.25	0.39	random
Chrysophyllum marginatum (Hook. & Arn.) Radlk. ssp. *marginatum*	0.92	1.25	0.54	random
Sideroxylon obtusifolium (Roem. & Schult.) T.D. Penn.	0.67	1.00	0.58	random

Table 5.3.1.3.2.c
Species sorted by IVI values. A: Absolute abundance; F: Absolute frequency as a percentage; D: Absolute dominance; IVI: Importance Value Index

N°	Species	To	F	D	IVI
1	*Sorocea saxicola*	0.18	75	54.18	56.67
2	*Parapiptadenia rigida*	0.09	100	31.17	35.80
3	*Syagrus romanzoffiana*	0.11	100	17.59	29.77
4	*Pisonia zucchini*	0.09	50	22.91	26.51
5	*Ruprechtia laxiflora*	0.11	25	20.54	24.83
6	*Eugenia uniflora*	0.06	75	2.56	13.93
7	*Sideroxylon obtusifolium*	0.04	75	3.71	12.69
8	*Chrysophyllum marginatum* ssp. *marginatum*	0.05	75	2.00	12.65
9	*Schinopsis balansae*	0.03	50	4.69	10.08
10	*Copernicia alba*	0.03	50	2.17	8.60
11	*Gleditsia amorphoides*	0.03	50	1.45	8.18
12	*Tabebuia nodosa*	0.02	50	0.75	6.81
13	Indet 3	0.03	25	1.39	5.92
14	Indet 1	0.02	25	1.76	5.18
15	*Cordia americana*	0.02	25	1.13	4.81
16	*Plinia rivularis*	0.02	25	0.30	4.32
17	*Libidybia paraguariensis*	0.01	25	1.02	3.78
18	*Peltophorum dubium*	0.01	25	0.33	3.38
19	*Machaerium* sp	0.01	25	0.33	3.37
20	Indet 2	0.01	25	0.21	3.31
21	*Guazuma ulmifolia*	0.01	25	0.16	3.28
22	*Zanthoxylum fagara* ssp. *Fagara*	0.01	25	0.12	3.26
23	*Casearia* sp	0.01	25	0.09	3.24
24	*Vachellia caven*	0.01	25	0.07	3.22
25	*Randia armata*	0.01	25	0.05	3.22
26	*Coccoloba* aff. *cordata*	0.01	25	0.05	3.21

Table 5.3.1.3.2.d
Combined list of floristic composition in the semi-deciduous subhumid forest of the terrain

N°	Family	Species	Common name
1	Acanthaceae	*Brazilian Justice Roth*	
2	Acanthaceae	*Justice sp*	
3	Acanthaceae	*Ruellia sp*	
4	Alismataceae	*Echinodorus grandiflorus (Cham. & Schltdl.) Micheli*	Cucharero
5	Amaranthaceae	*Pfaffia glomerata (Spreng.) Pedersen*	Batatilla
6	Anacardiaceae	*Schinopsis balansae Engl.*	Quebracho colorado
7	Annonaceae	*Annona emarginata (Schltdl.) H. Rainer.*	Aratiku'i
8	Apocynaceae	*Forsteronia sp*	
9	Araceae	*Anthurium paraguayense Engl.*	Kalaguala guasu
10	Arecaceae	*Copernicia alba Morong*	Karanda'y
11	Arecaceae	*Syagrus romanzoffiana (Cham.) Glassman*	Pindo
12	Asteraceae	*Eclipta prostata (L.) L.*	Tangara ka'a
13	Asteraceae	*Eupatorium sp 1*	
14	Asteraceae	*Vernonanthura sp*	
15	Asteraceae	*Viguiera sp*	
16	Bignoniaceae	*Dolichandra cynanchoides Cham.*	
17	Bignoniaceae	*Dolichandra unguis-cati (L.) L.G. Lohmann.*	Uña de gato
18	Bignoniaceae	*Tabebuia nodosa (Griseb.) Griseb.*	Labón
19	Boraginaceae	*Cordia americana (L.) Gottschling & J.S. Mill.*	Guajayvi
20	Bromeliaceae	*Bromeliad balansae Mez*	Karaguata
21	Bromeliaceae	*Tillandsia recurvata (L.) L.*	Clavel del aire
22	Bromeliaceae	*Tillandsia recurvifolia Hook.*	Clavel del aire
23	Bromeliaceae	*Tillandsia streptocarpa Baker*	Clavel del aire
24	Bromeliaceae	*Tillandsia usneoides (L.) L.*	
25	Cactaceae	*Harrisia sp*	
26	Cactaceae	*Rhipsalis baccifera (J.S.Muell.) Stearn*	Suelta con suelta
27	Cactaceae	*Rhipsalis lumbricoides (Lem.) Lem. ex Salm-Dyck.*	
28	Cannabaceae	*Celtis sp*	Juasy'y
29	Capparaceae	*Cynophalla retusa (Griseb.) X. Dogwood & H.H. Iltis*	Indio kumanda

Table 5.3.1.3.2.d
Combined list of floristic composition in the semi-deciduous subhumid forest of the terrain

N°	Family	Species	Common name
30	Celastraceae	*Monteverdia ilicifolia (Mart. ex Reissek) Biral*	Kangorosa
31	Cleomaceae	*Tarenaya aculeata (L.) Soares Neto & Roalson*	
32	Commelinaceae	*Commelina diffusa Burm. f.*	Saint Lucia hovy
33	Commelinaceae	*Commelina erecta L.*	Saint Lucia hovy
34	Convolvulaceae	*Dichondra microcalyx (Hallier f.) Fabris*	
35	Convolvulaceae	*Ipomoea sp 1*	
36	Convolvulaceae	*Ipomoea sp 2*	
37	Cyperaceae	*Cyperus entrerianus Boeck.*	
38	Cyperaceae	*Cyperus odoratus L.*	
39	Cyperaceae	*Scleria sp*	
40	Euphorbiaceae	*Caperonia castaneifolia (L.) A. St.-Hil.*	
41	Euphorbiaceae	*Croton bonplandianus Baill.*	
42	Euphorbiaceae	*Gymnanthes discolor (Spreng.) Müll. Arg.*	
43	Euphorbiaceae	*Sebastiania ramosissima (A. St.-Hil.), A.L. Melo & M.F. Sales*	Yvyra kamby
44	Euphorbiaceae	*Tragia sp*	
45	Fabaceae	*Aeschynomene montevidensis Vogel*	
46	Fabaceae	*Calliandra sp*	Niño azote
47	Fabaceae	*Gleditsia amorphoides (Griseb.) Taub.*	Yvope
48	Fabaceae	*Indet 2*	
49	Fabaceae	*Undetermined*	
50	Fabaceae	*Indigofera asperifolia Bong. ex Benth.*	
51	Fabaceae	*Libidibia paraguariensis (D. Parodi) G.P. Lewis*	Guayacán
52	Fabaceae	*Machaerium sp*	
53	Fabaceae	*Macroptilium erythroloma (Mart. ex Benth.) Urb.*	
54	Fabaceae	*Neltuma affinis (Spreng.) C.E. Hughes & G.P. Lewis*	Algarrobillo
55	Fabaceae	*Parapiptadenia rigida (Benth.) Brenan*	Kurupa'yrâ
56	Fabaceae	*Peltophorum dubium (Spreng.) Taub.*	Yvyra pytâ
57	Fabaceae	*Prosopis nigra (Griseb.) They wounded.*	Algarrobo negro
58	Fabaceae	*Vachellia caven (Molina) Seigler & Ebinger*	Aromita

Table 5.3.1.3.2.d
Combined list of floristic composition in the semi-deciduous subhumid forest of the terrain

N°	Family	Species	Common name
59	Undetermined	*Indet 1*	
60	Iridaceae	*Sisyrinchium sp*	
61	Lamiaceae	*Salvia cardiophylla Benth.*	
62	Lauraceae	*Ocotea diospyrifolia (Meisn.) Mez*	Laurel
63	Malpighiaceae	*Janusia sp*	
64	Malvaceae	*Guazuma ulmifolia Lam.*	Kamba akâ
65	Malvaceae	*Sida rhombifolia L.*	Typycha hû
66	Malvaceae	*Sidastrum paniculatum (L.) Fryxell*	
67	Malvaceae	*Wissadula sp*	
68	Meliaceae	*Trichilia catigua A.Juss.*	Katigua pytâ
69	Meliaceae	*Trichilia sp*	
70	Moraceae	*Sorocea saxicola Hassl.*	Ñandypami
71	Myrtaceae	*Campomanesia xanthocarpa (Mart.) O.Berg*	Guavira pytâ
72	Myrtaceae	*Eugenia sp*	
73	Myrtaceae	*Eugenia uniflora L.*	Ñangapiry
74	Myrtaceae	*Indet 3*	
75	Myrtaceae	*Plinia rivularis (Cambess.) Rotman*	Yvaporoity
76	Nyctaginaceae	*Pisonia Griseb Pumpkin.*	Jukyryvusu
77	Orchidaceae	*Campylocentrum neglectum (Rchb. f. & Warm.) Cogn.*	
78	Orchidaceae	*Cohniella jonesiana (Rchb. f.) Christenson*	
79	Orchidaceae	*Cyclopogon sp*	
80	Orchidaceae	*Trichocentrum pumilum (Lindl.) M.W. Chase & N.H. Williams*	
81	Passifloraceae	*Passiflora giberti N.E. Br.*	Mburkuja'i
82	Petiveriaceae	*Petiveria alliacea L.*	Pipi
83	Phytolaccaceae	*Rivinia humilis L.*	
84	Piperaceae	*Peperomia sp*	
85	Plantaginaceae	*Angelonia salicariifolia Bonpl.*	
86	Plantaginaceae	*Bacopa salzmanii (Benth.) Wettst. ex Edwall*	
87	Poaceae	*Undetermined*	

Table 5.3.1.3.2.d
Combined list of floristic composition in the semi-deciduous subhumid forest of the terrain

N°	Family	Species	Common name
88	Poaceae	*Lasiasis sp*	
89	Poaceae	*Leersia hexandra Sw.*	
90	Poaceae	*Ocellochloa stolonifera (Poir.) Zuloaga & Morrone*	
91	Poaceae	*Panicum sp*	
92	Poaceae	*Paspalum sp*	Pasto
93	Polygonaceae	*Coccoloba aff. cordata Cham.*	Duraznillo Moado
94	Polygonaceae	*Coccoloba paraguariensis Lindau*	
95	Polygonaceae	*Polygonum punctatum Elliott*	Ka'atai
96	Polygonaceae	*Ruprechtia laxiflora Meisn.*	Yvyra pytâ'i
97	Polypodiaceae	*Microgramma aff. Squamulosa*	
98	Polypodiaceae	*Microgramma vacciniifolia Langsd & Fisch*	Anguja nambi
99	Pteridaceae	*Hemionitis tomentosa (Lam.) Raddi*	Doradilla
100	Rubiaceae	*Guettarda uruguensis Cham. & Schltdl.*	
101	Rubiaceae	*Manettia sp*	
102	Rubiaceae	*Psychotria sp*	
103	Rubiaceae	*Randia armata (Sw.) DC.*	Ñuatî kurusu
104	Rutaceae	*Zanthoxylum fagara (L.) Sarg. ssp. fagara*	Mbarakaja pyâpe
105	Salicaceae	*Casearia gossypiosperma Briq.*	Mbavy
106	Salicaceae	*Casearia sp*	
107	Salicaceae	*Xylosma venosum N.E.Brown.*	Ñuati creek
108	Sapindaceae	*Allophylus edulis (A. St.-Hil., A. Juss. & Cambess.) They wounded. ex Niederl.*	Kokû
109	Sapindaceae	*Paullinia sp*	
110	Sapindaceae	*Serjania sp*	
111	Sapotaceae	*Chrysophyllum marginatum (Hook. & Arn.) Radlk. ssp. marginatum*	Pykasu rembi'u
112	Sapotaceae	*Sideroxylon obtusifolium (Roem. & Schult.) T.D. Penn.*	Guajayvirai
113	Smilaceae	*Smilax sp*	
114	Solanaceae	*Solanum americanum Mill.*	Arachichu
115	Solanaceae	*Solanum glaucophyllum Desf.*	Duraznillo
116	Solanaceae	*Solanum sp*	

Table 5.3.1.3.2.d
Combined list of floristic composition in the semi-deciduous subhumid forest of the terrain

N°	Family	Species	Common name
117	Verbenaceae	*Glandularia peruviana (L.) Small.*	Yvoty la novia
118	Verbenaceae	*Phyla nodiflora (L.) Greene*	
119	Verbenaceae	*Stachytarpheta cayennensis (Rich.) Vahl*	Tatu ruguái
120	Verbenaceae	*Verbena litoralis Kunth*	
121	Vitaceae	*Cissus verticillata (L.) Nicolson & C.E. Jarvis.*	Ka'avurâ

Table 5.3.1.3.2.e
List of species recorded in the second sampling of the savannah

N°	Family	Species	Common name
1	Alismataceae	*Helanthium* sp.	
2	Amaranthaceae	*Alternanthera* kurtzii Schinz ex Pedersen ssp. *Kurtzii*	
3	Amaranthaceae	*Pfaffia glomerata* (Spreng.) Pedersen	Batatilla
4	Apiaceae	*Eryngium elegans* Cham. & Schltdl.	Karaguata'y
5	Apocynaceae	*Mandevilla angustifolia* (Malme) Woodson	
6	Araliaceae	*Hydrocotyle ranunculoides* L. f.	Akaryso
7	Arecaceae	*Copernicia alba* Morong	Karanda'y
8	Asteraceae	*Chromolaena laevigata* (Lam.) R.M. King & H. Rob. var. *Laevigata*	
9	Asteraceae	*Eclipta prostata* (L.) L.	
10	Asteraceae	*Eupatorium* sp1	
11	Asteraceae	*Eupatorium* sp2	
12	Asteraceae	INDET 1	
13	Asteraceae	Indet 2	
14	Asteraceae	Indet 3	
15	Asteraceae	INDET 4	
16	Asteraceae	*Pterocaulon virgatum* (L.) DC.	Bull Ka'a
17	Asteraceae	*Vernonia* sp	
18	Bignoniaceae	*Tabebuia nodosa* (Griseb.) Griseb.	Labon
19	Bromeliaceae	*Tillandsia recurvifolia* Hook.	Clavel del aire
20	Commelinaceae	*Commelina erecta* L.	Santa Lucia
21	Convolvulaceae	*Ipomoea carnea* Jacq. subsp. *fistulosa* (Mart. ex Choisy). D.F. Austin	Mandyjurâ
22	Convolvulaceae	*Ipomoea* sp1	
23	Convolvulaceae	*Ipomoea* sp2	
24	Cyperaceae	*Cyperus* aff. *digitatus* Roxb.	
25	Cyperaceae	*Cyperus entrerianus* Boeck. var. *entrerianus*	
26	Cyperaceae	*Cyperus odoratus* L.	
27	Cyperaceae	*Cyperus sesquiflorus* (Torr.) Mattf. & Kük. ex Kük.	
28	Cyperaceae	*Eleocharis elegans* (Kunth) Roem. & Schult.	
29	Cyperaceae	*Eleocharis filiculmis* Kunth Kunth	
30	Cyperaceae	*Rhynchospora* sp	
31	Euphorbiaceae	*Caperonia castaneifolia* (L.) A. St.-Hil.	
32	Euphorbiaceae	*Caperonia palustris* (L.) A. St.-Hil.	
33	Fabaceae	*Aeschynomene* sp	
34	Fabaceae	*Macroptilium erythroloma* (Mart. ex Benth.) Urb.	
35	Fabaceae	*Mimosa balansae* Micheli	
36	Fabaceae	*Mimosa debilis* Humb. & Bonpl. ex Willd. var. *Weakness*	
37	Fabaceae	*Mimosa* sp	
38	Fabaceae	Senna pendula (Willd.) H.S. Irwin & Barneby var. H.S. Irwin & Barneby	Taperyvami
39	Fabaceae	*Sesbania virgata* (Cav.) Poir.	Acacia negra
40	Fabaceae	*Vachellia caven* (Molina) Seigler & Ebinger	Aromita
41	Lythraceae	*Cuphea lysimachioides* Cham. & Schltdl.	
42	Lythraceae	*Cuphea racemosa* (L. f.) Spreng. ssp. *racemosa*	7 sangría
43	Lythraceae	*Cuphea* sp1	
44	Lythraceae	*Cuphea* sp2	
45	Malvaceae	*Hibiscus* sp	

Table 5.3.1.3.2.e
List of species recorded in the second sampling of the savannah

N°	Family	Species	Common name
46	Malvaceae	*Pavonia* sp	
47	Malvaceae	*Sida* aff. *potentilloides* A. St.-Hil.	
48	Malvaceae	*Sida spinosa* L.	Typycha hû
49	Malvaceae	*Sidastrum paniculatum* (L.) Fryxell	
50	Menyanthaceae	*Nymphoides indica* (L.) Kuntze	Camalotillo
51	Onagraceae	*Ludwigia decurrens* Walter	
52	Orobanchaceae	*Agalinis communis* (Cham. & Schltdl.) D'Arcy	
53	Orobanchaceae	*Agalinis genistifolia* (Cham. & Schltdl.) D'Arcy	
54	Oxalidaceae	*Oxalis paludosa* A. St.-Hil.	
55	Passifloraceae	*Passiflora misera* Kunth misera Kunth	
56	Phyllanthaceae	*Moeroris stipulata* Raf.	
57	Plataginaceae	*Bacopa salzmannii* (Benth.) Wettst. ex Edwall	
58	Plataginaceae	*Mecardonia procumbens* (Mill.) Small var. *flagellaris* (Cham. & Schltdl.) V.C. Souza	
59	Poaceae	*Panicum* sp	
60	Poaceae	*Paspalum* sp1	
61	Poaceae	*Echinochloa colona* (L.) Link	
62	Poaceae	*Hymenachne amplexicaulis* (Rudge) Nees	Camalotillo
63	Poaceae	*Lasiacis* sp	
64	Poaceae	*Leersia hexandra* Sw.	
65	Poaceae	*Paspalum* sp2	
66	Poaceae	*Setaria* sp	
67	Polygonaceae	*Muehlenbeckia sagittifolia* (Ortega) Meisn.	Zarzararrila
68	Pontederiaceae	*Pontederia cordata* L. var. *cordata*	Aguapé
69	Salicaceae	*Xylosma venosum* N.E.Brown.	Ñuatî arroyo
70	Solanaceae	*Sypy integrifolia* Lam.	
71	Solanaceae	*Solanum glaucophyllum* Desf.	Duraznillo
72	Vitaceae	*Cissus palmata* Poir.	

Table 5.3.1.3.2.f
Combined list of species recorded in the hydromorphic savannah of *Copernicia alba*

N°	Family	Species	Common name
1	Acanthaceae	*Justice sp*	
2	Acanthaceae	*Ruellia sp*	
3	Alismataceae	*Helanthum* sp	
4	Amaranthaceae	*Alternanthera kurtzii Schinz ex Pedersen* ssp. kurtzii	
5	Amaranthaceae	*Alternanthera* sp	
6	Amaranthaceae	*Gomphrena celosioides Mart.*	Perdudilla
7	Amaranthaceae	*Gomphrena perennis L.*	Siempreviva
8	Amaranthaceae	*Pfaffia glomerata (Spreng.) Pedersen*	Batatilla
9	Annonaceae	*Annona emarginata (Schltdl.) H. Rainer.*	Aratiku'i
10	Apiaceae	*Eryngium elegans Cham. & Schltdl.*	
11	Apocynaceae	*Mandevilla angustifolia (Malme) Woodson*	
12	Apocynaceae	*Oxypetalum sp*	
13	Araliaceae	*Hydrocotyle ranunculoides L. f.*	Akaryso
14	Arecaceae	*Copernicia alba Morong*	Karanda'y
15	Arecaceae	*Syagrus romanzoffiana (Cham.) Glassman*	Pindo
16	Asteraceae	*Aspilia* sp	
17	Asteraceae	*Chromolaena laevigata (Lam.) R.M. King & H. Rob. Var. Laevigata*	
18	Asteraceae	*Coniza* sp	
19	Asteraceae	*Eclipta prostata (L.) L.*	
20	Asteraceae	*Eupatorium* sp 2	
21	Asteraceae	*Eupatorium* sp1	
22	Asteraceae	*Gamochaeta* sp	
23	Asteraceae	*INDET 1*	
24	Asteraceae	*Indet 2*	
25	Asteraceae	*Indet 3*	
26	Asteraceae	*INDET 4*	
27	Asteraceae	*Mikania* sp	
28	Asteraceae	*Pluchea sagittalis (Lam.) Cabrera*	Yerba de lucero
29	Asteraceae	*Pterocaulon* sp	

Table 5.3.1.3.2.f
Combined list of species recorded in the hydromorphic savannah of *Copernicia alba*

N°	Family	Species	Common name
30	Asteraceae	*Pterocaulon virgatum (L.) DC.*	
31	Asteraceae	*Vernonia* sp	
32	Bignoniaceae	*Dolichandra unguis-cati (L.) L.G. Lohmann.*	Uña de gato
33	Bignoniaceae	*Tabebuia nodosa (Griseb.) Griseb.*	Labon
34	Boraginaceae	*Heliotropium* sp	
35	Brassicaceae	*Lepidium bonariense L.*	
36	Bromeliaceae	*Bromeliad balansae Mez*	Karaguata
37	Bromeliaceae	*Tillandsia recurvata (L.) L.*	Clavel del aire
38	Bromeliaceae	*Tillandsia recurvifolia Hook.*	Clavel del aire
39	Cleomaceae	*Tarenaya aculeata (L.) Soares Neto & Roalson*	
40	Commelinaceae	*Commelina diffusa Burm. f.*	
41	Commelinaceae	*Commelina erecta L.*	Santa Lucia hovy
42	Commelinaceae	*Tradescantia fluminensis Vell.*	
43	Convolulaceae	*Ipomoea carnea Jacq. subsp. fistulosa (Mart. ex Choisy). D.F. Austin*	Mandyjurâ
44	Convolulaceae	*Ipomoea* sp1	
45	Convolulaceae	*Ipomoea* sp2	
46	Cyperaceae	*Cyperus aff. digitatus Roxb.*	
47	Cyperaceae	*Cyperus aggregatus (Willd.) Endl.*	
48	Cyperaceae	*Cyperus brevifolius (Rottb.) Hassk.*	
49	Cyperaceae	*Cyperus entrerianus Boeck. Var. entrerianus*	
50	Cyperaceae	*Cyperus odoratus L.*	
51	Cyperaceae	*Cyperus sesquiflorus (Torr.) Mattf. & Kük. ex Kük.*	
52	Cyperaceae	*Eleocharis elegans (Kunth) Roem. & Schult.*	
53	Cyperaceae	*Eleocharis filiculmis Kunth Kunth*	
54	Cyperaceae	*Rhynchospora* sp	
55	Cyperaceae	*Rhynchospora* sp 2	
56	Cyperaceae	*Scleria* sp	
57	Euphorbiaceae	*Caperonia castaneifolia (L.) A. St.-Hil.*	
58	Euphorbiaceae	*Caperonia palustris (L.) A.St.- Hil.*	

Table 5.3.1.3.2.f
Combined list of species recorded in the hydromorphic savannah of *Copernicia alba*

N°	Family	Species	Common name
59	Euphorbiaceae	*Croton argenteus L.*	
60	Euphorbiaceae	*Croton bonplandianus Baill.*	
61	Fabaceae	*Aeschynomene montevidensis Vogel*	
62	Fabaceae	*Aeschynomene* sp	
63	Fabaceae	*Desmodium* sp	
64	Fabaceae	*Macroptilium erythroloma (Mart. ex Benth.) Urb.*	
65	Fabaceae	*Mimosa balansae Micheli*	
66	Fabaceae	*Mimosa debilis Humb. & Bonpl. ex Willd. Var. Weakness*	
67	Fabaceae	*Mimosa* sp	
68	Fabaceae	*Neltuma affinis (Spreng.) C.E. Hughes & G.P. Lewis*	
69	Fabaceae	*Neptunia* sp	
70	Fabaceae	Senna obtusifolia (L.) H.S. Irwin & Barneby	Taperyva
71	Fabaceae	*Senna pendula (Willd.) H.S. Irwin & Barneby var. H.S. Irwin & Barneby*	Taperyvami
72	Fabaceae	*Sesbania virgata (Cav.) Poir.*	Acacia negra
73	Fabaceae	*Vachellia caven (Molina) Seigler & Ebinger*	Aromita
74	Hydroleaceae	*Hydrolea spinosa L.*	
75	Lentibulariaceae	*Utricularia foliosa L.*	
76	Lythraceae	*Cuphea lysimachioides Cham. & Schltdl.*	
77	Lythraceae	*Cuphea racemosa (L. f.) Spreng. ssp. racemosa*	7 sangría
78	Lythraceae	*Cuphea* sp1	
79	Lythraceae	*Cuphea* sp2	
80	Lythraceae	*Heimia salicifolia Link.*	Yerba de la vida
81	Malvaceae	*Guazuma ulmifolia Lam.*	Kamba akâ
82	Malvaceae	*Hibiscus* sp	
83	Malvaceae	*Pavonia* sp	
84	Malvaceae	*Sida aff. potentilloides A. St.-Hil.*	
85	Malvaceae	*Sida rhombifolia L.*	Typycha hû
86	Malvaceae	*Sida spinosa L.*	Typycha hû
87	Malvaceae	*Sidastrum paniculatum (L.) Fryxell*	

Table 5.3.1.3.2.f
Combined list of species recorded in the hydromorphic savannah of *Copernicia alba*

N°	Family	Species	Common name
88	Menyanthaceae	*Nymphoides indica (L.) Kuntze*	Camalotillo
89	Onagraceae	*Ludwigia decurrens Walter*	Duraznillo de agua
90	Orobanchaceae	*Agalinis communis (Cham. & Schltdl.) D'Arcy*	
91	Orobanchaceae	*Agalinis genistifolia (Cham. & Schltdl.) D'Arcy*	
92	Oxalidaceae	*Oxalis paludosa A. St.-Hil.*	
93	Passifloraceae	*Passiflora misera Kunth misera Kunth*	
94	Phyllanthaceae	*Moeroris stipulata Raf.*	
95	Plantaginaceae	*Angelonia salicariifolia Bonpl.*	
96	Plantaginaceae	*Bacopa salzmannii (Benth.) Wettst. ex Edwall*	
97	Plantaginaceae	*Mecardonia procumbens (Mill.) Small var. flagellaris (Cham. & Schltdl.) V.C. Souza*	
98	Poaceae	*Cenchrus* sp	
99	Poaceae	*Paspalum* sp1	
100	Poaceae	*Coleataenia prionitis (Nees) Soreng.*	Cortadera
101	Poaceae	*Panicum* sp2	
102	Poaceae	*Echinochloa colona (L.) Link*	
103	Poaceae	*Hymenachne amplexicaulis (Rudge) Nees*	Camalotillo
104	Poaceae	*Lasiacis* sp	
105	Poaceae	*Leersia hexandra Sw.*	
106	Poaceae	*Panicum* sp	
107	Poaceae	*Paspalum* sp2	
108	Poaceae	*Setaria* sp	
109	Poaceae	*Steinchisma hians (Elliott) Nash*	
110	Polygonaceae	*Muehlenbeckia sagittifolia (Ortega) Meisn.*	Zarzaparilla colorada
111	Polygonaceae	*Polygonum punctatum Elliott*	Ka'atai
112	Pontederiaceae	*Pontederia cordata L. var. cordata*	Aguape
113	Portulacaceae	*Portulaca* sp	
114	Rubiaceae	*Borreria verticillata (L.) G. Mey.*	Typycha Runner
115	Rubiaceae	*Randa armata (Sw.) DC.*	Ñuatî kurusu
116	Rubiaceae	*Richardia brasiliensis Gomes*	Ype rupa

Table 5.3.1.3.2.f
Combined list of species recorded in the hydromorphic savannah of *Copernicia alba*

N°	Family	Species	Common name
117	Salicaceae	*Xylosma venosum N.E.Brown.*	Ñuatî arroyo
118	Sapindaceae	*Serjania* sp	
119	Smilacaceae	*Smilax* sp	
120	Solanaceae	*Sypy integrifolia Lam.*	
121	Solanaceae	*Solanum glaucophyllum Desf.*	Duraznillo
122	Solanaceae	*Solanum* sp	
123	Verbenaceae	*Salvia cardiophylla Benth.*	
124	Verbenaceae	*Stachytarpheta cayennensis (Rich.) Vahl*	Tatu ruguái
125	Vitaceae	*Cissus palmata Poir.*	
126	Vitaceae	*Cissus verticillata (L.) Nicolson & C.E. Jarvis.*	

JGP

atome

Annex 9 – Fauna Photographic Record

Photo 01: Lake located partly on the Project grounds and partly on a neighbouring property (First Campaign).

Photo 02: Detail of the environment sampled by the wildlife team (First Campaign).

Photo 03: Palm trees and small isolated trees registered in the vicinity of the Project (First Campaign).

Photo 04: Detail of the environment sampled by the wildlife team (Second Campaign)
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Photo 05: Detail of the environment sampled by the wildlife team (Second Campaign).

Photo 06: Detail of the environment sampled by the wildlife team (Second Campaign).

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Photo 07: Detail of the environment sampled by the wildlife team (Second Campaign).

Photo 08: Detail of the environment sampled by the wildlife team (Second Campaign).

Photo 09: Detail of the environment sampled by the wildlife team (Second Campaign).

Photo 10: Inspection for the installation of camera traps and bioacoustic equipment (Songmeter) (First Campaign).

Photos 11 and 12: Installation of camera trap. The locations of the camera traps were selected by the team (First Campaign).

	
Photo 13: Installation of camera trap. The locations of the camera traps were selected by the team (Second Campaign).	**Photo 14**: Detail of the camera trap installed (First Campaign).
	
Figure 15: Field data collection using GPS (First Campaign).	**Figure 16**: Field data collection using GPS (Second Campaign).
	
Photo 17: Detail of the Songmeter bioacoustic device installed for the detection of bats (First Campaign).	**Photo 18**: Detail of the Songmeter bioacoustic device installed for the detection of bats (Second Campaign).

Figure 19: Study of the birdlife with binoculars (First Campaign).

Photo 20: Study of birdlife with binoculars (Second Campaign).

Photo 21: Active search for traces of wildlife (First Campaign).

Photo 22: Diurnal census of amphibians and reptiles (Second Campaign).

Photo 23: Active nocturnal search for herpetofauna (Second Campaign).

Photo 24: Active nocturnal search for mastofauna (Second Campaign).

Photo 25: *Alouatta caraya* (howler monkey) (First Campaign).

Photo 26: *Alouatta caraya* (howler monkey) (Second Campaign).

Photo 27: Feces of *Alouatta caraya* (howler monkey) (First Campaign).

Photo 28: Feces of *Alouatta caraya* (howler monkey) (Second Campaign).

Photo 29: Footprint of *Cerdocyon thous* (crabeater fox) (First Campaign).

Photo 30: Footprint of *Dasypus novemcinctus* (big mule) (Second Campaign).

Foto 31: Footprint of *Subulo gouazoubira* (roe deer) (Second Campaign).

Photo 32: Footprint of *Procyon cancrivorus* (crab-eating raccoon) (Second Campaign).

Photo 33: Feline feces (First Campaign).

Photo 34: *Sylvilagus brasiliensis* (wild bunny) feces (First Campaign).

Foto 35: Roadkill *Procyon cancrivorus* (First Campaign).

Photo 36: Footprint of *Subulo gouazoubira* (roe deer) (First Campaign).

Photo 37: *Alouatta caraya* (howler monkey) run over (First Campaign).

Photo 38: Footprint of *Dasypus novemcinctus* (large mule) (First Campaign).

Photo 39: *Didelphis albiventris* (common weasel) recorded on camera trap (First Campaign).

Photo 40: *Subulo gouazoubira* (roe deer) recorded on camera trap (First Campaign).

Photo 41: *Leopardus geoffroyi* (wildcat) recorded on camera trap (First Campaign).

Photo 42: *Cerdocyon thous* (crabeater fox) recorded on camera trap (First Campaign).

Photo 43: *Herpailurus yagouaroundi* (Moorish cat) recorded on camera trap (First Campaign).

Photo 44: *Daypus novemcinctus* (big mule) recorded on camera trap (First Campaign).

Photo 45: *Cerdocyon thous* (crabeater fox) recorded on camera trap (Second Campaign).

Foto 46: *Didelphis albiventris* (common weasel) recorded on camera trap (Second Campaign).

Photo 47: *Didelphis albiventris* (common weasel) recorded on camera trap (Second Campaign).

Photo 48: *Procyon cancrivorus* (crab-eating raccoon) recorded on camera trap (First Campaign).

Photo 49: *Philander quica* (four-eyed weasel) recorded on camera trap (Second Campaign).

Photo 50: *Sylvilagus brasiliensis* (wild bunny) recorded on camera trap (First Campaign).

Photo 51: *Rhinella diptycha* (Kururu) (First Campaign).

Photo 52: *Leptodactylus podicipinus* (Frog) (First Campaign).

Photo 53: *Rhinella diptycha* (Kururu) (Second Campaign).

Photo 54: *Leptodactylus macrosternum* (Frog) (Second Campaign).

Photo 55: *Leptodactulus latinasus* (Frog) (Second Campaign).

Photo 56: *Leptodactylus* fuscus (Rana, Ju'i) (First Campaign).

Photo 57: *Rhinella azarai* (Kururu toad) (Second Campaign).

Photo 58: *Odontophrynus americanus* (Frog) (Second Campaign).

Photo 59: *Bolivian Pseudopaludicola* (Frog) (First Campaign).

Photo 60: *Bolivian Pseudopaludicola* (Frog) (Second Campaign).

Photo 61: *Dryophylax chaquensis* (Cat's Eye, Mboi capi'i) (Second Campaign).

Photo 62: *Boana raniceps* (Bramble Frog, Ju'i pakova) (Second Campaign).

Photo 63: *Physalaemus* sp2. (Rana, Ju'i) (Second Campaign).

Photo 64: *Scinax acuminatus* (Pool frog, Ju'i latrine) (Second Campaign).

Photo 65: *Hydrodynastes gigas* (Ñacaniná) (Second Campaign).

Photo 66: *Erythrolamprus poecilogyrus* (Snake, Captain Mboi) (Second Campaign).

Figure 67: *Amazona aestiva* (Talking Parrot) (First Campaign).

Photo 68: *Xiphocolaptes major* (Giant Nuthatch) (First Campaign).

Photo 69: *Euphonia chlorotica* (tanager) (first campaign).

Photo 70: *Pachyramphus viridis* (Greenish Anambé) (First Campaign).

Photo 71: *Aramides ypecaha* (moorhen) (Second Campaign).

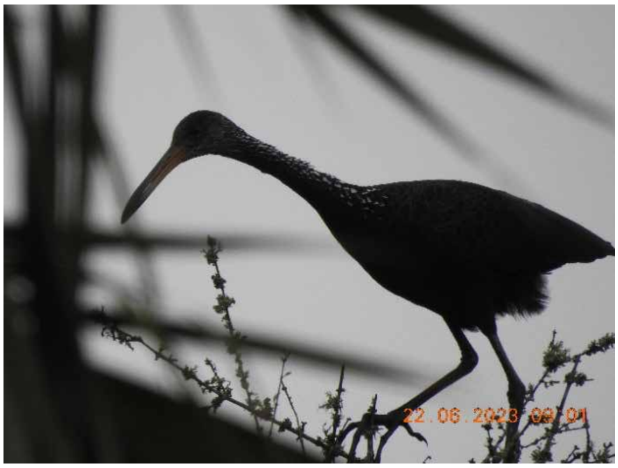

Photo 72: *Aramus guarauna* (carau) (Second Campaign).

	
Photo 73: *Campephilus leucopogon* (White-backed Woodpecker) (Second Campaign).	**Photo 74**: *Chloroceryle amazona* (medium-sized kingfisher) (Second Campaign).
	
Photo 75: *Columbina squammata* (scaly popcorn) (Second Campaign).	**Photo 76**: *Icterus pyrrhopterus* (Little Boy) (Second Campaign).
	
Photo 77: *Melanerpes cactorum* (cactus woodpecker) (Second Campaign).	**Photo 78**: *Milvago chimachima* (chimachima) (Second Campaign).

Photo 79: *Paroaria coronata* (cardinal) (Second Campaign).

Photo 80: *Piculus chrysochloros* (golden woodpecker) (Second Campaign).

Photo 81: *Pionus maximiliani* (Chocolate Parrot) (Second Campaign).

Photo 82: *Polioptila dumicola* (blue tacuarite) (Second Campaign).

Photo 83: *Pyrocephalus rubinus* (churrinche) (Second Campaign).

Photo 84: *Pyrrhura frontalis* (green-headed chiripepé) (Second Campaign).

Photo 85: *Xiphocolaptes major* (giant climber) (Second Campaign).

Photo 86: *Xiphocolaptes major* (Giant Nuthatch) (Second Campaign).

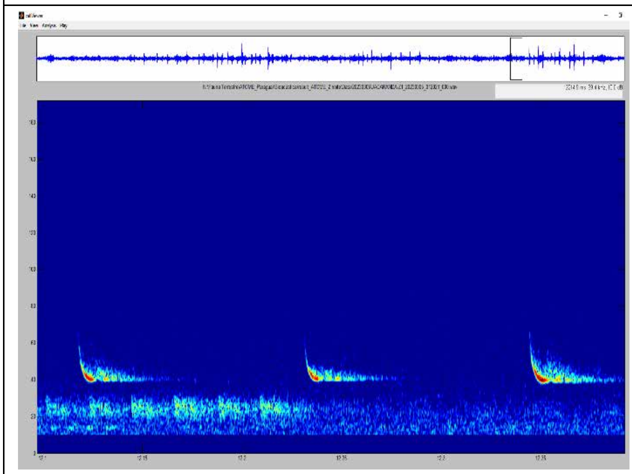

Photo 87: Acoustic signal of *Eptesicus furinalis* (bat) (First Campaign).

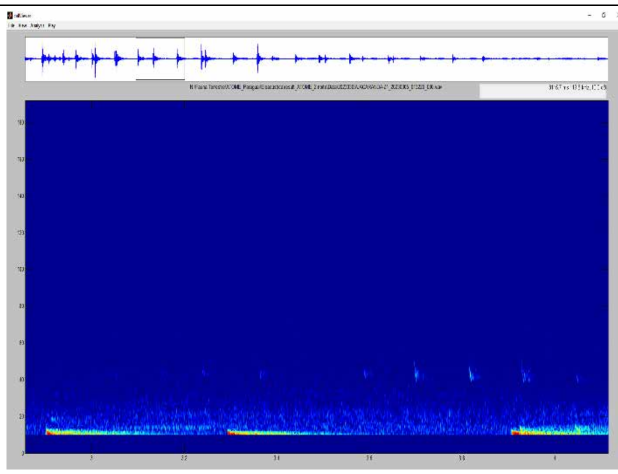

Photo 88: Acoustic signal of *Eumops perotis* (bat) (First Campaign).

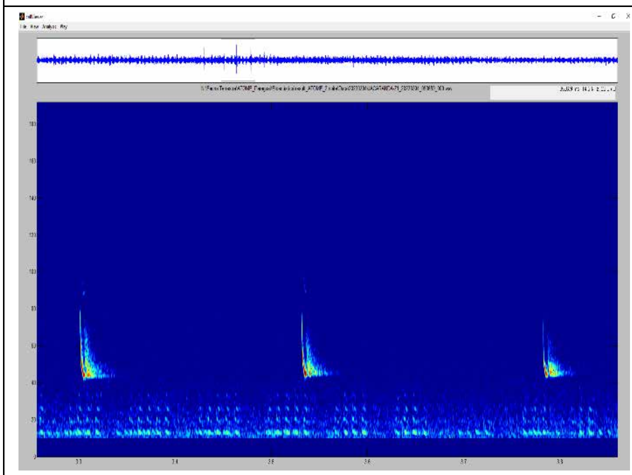

Photo 89: Acoustic signal of *Lasiurus blossevillii* (bat) (First Campaign).

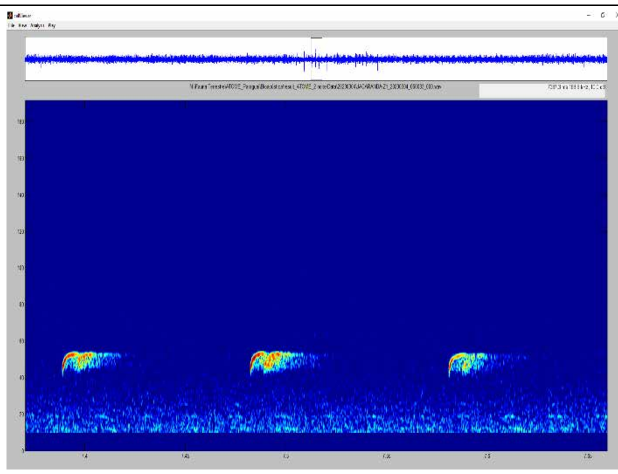

Photo 90: Acoustic signal of *Molossops temminckii* (bat) (First Campaign).

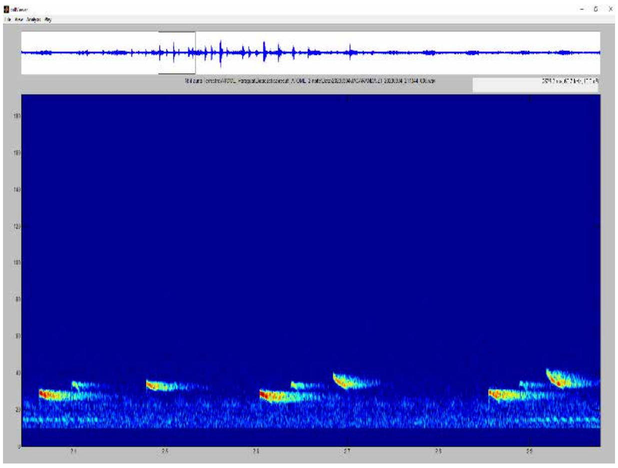	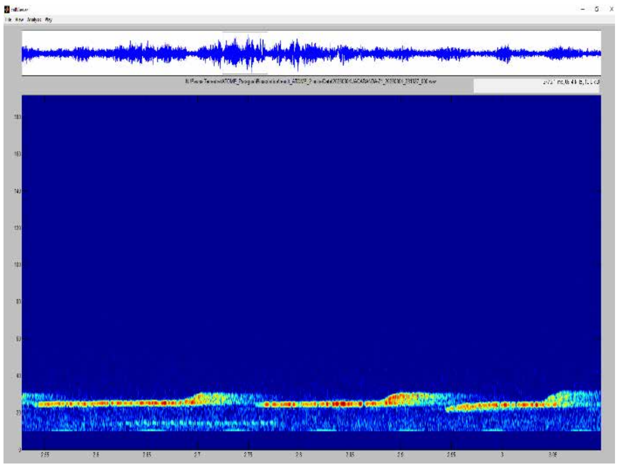
Photo 91: Acoustic signal of *Molossus rufus* (bat) (First Campaign).	**Photo 92**: Acoustic signal of *central Promops* (bat) (First Campaign).

Annex 10 – Lists of Fauna Species

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Lists of Avifauna Species

Table 5.3.2.4.1.a
List of species recorded during the first birding season

Order/Family/Species	Popular name	Records	Status of Conservation		
			MADES 2019	IUCN 2022	CITES 2023
Accipitriformes					
Accipitridae					
Rostrhamus sociabilis	Caracolero	1	-	LC	II
Rupornis magnirostris	Taguató común	4	-	LC	II
Anseriformes					
Anatidae					
Amazonetta brasiliensis	Patillo	1	-	LC	-
Cairina moschata	Bragado	8	-	LC	-
Dendrocygna autumnalis	Pato silbón ala blanca	53	-	LC	-
Dendrocygna viduata	Pato silbón cara blanca	1	-	LC	-
Anhimidae					
Chauna torquata	Chajá	2	-	LC	-
Apodiformes					
Trochilidae					
Chlorostilbon lucidus	Picaflor verde	1	-	LC	II
Heliomaster furcifer	Picaflor de barbijo	1	-	LC	II
Hylocharis chrysura	Picaflor bronceado	3	-	LC	II
Caprimulgiformes					
Caprimulgidae					
Lurocalis semitorquatus	Añapero castaño	1	-	LC	-
Cariamiformes					
Cariamidae					
Cariama cristata	Saría patas rojas	1	-	LC	-
Cathartiformes					
Cathartidae					
Cathartes burrovianus	Cuervo cabeza amarilla	1	-	LC	-

Table 5.3.2.4.1.a
List of species recorded during the first birding season

Order/Family/Species	Popular name	Records	Status of Conservation		
			MADES 2019	IUCN 2022	CITES 2023
Coragyps atratus	Cuervo negro	35	-	LC	-
Charadriiformes					
Charadriidae					
Vanellus chilensis	Tero tero	12	-	LC	-
Jacanidae					
Jacana jacana	Jacana	3	-	LC	-
Laridae					
Phaetusa simplex	Atí	1	-	LC	-
Scolopacidae					
Tringa solitaria	Pitotoi solitario	5	-	LC	-
Ciconiiformes					
Ciconiidae					
Ciconia maguari	Cigüeña americana	1	-	LC	-
Jabiru mycteria	Yabiru	37	-	LC	I
Mycteria americana	Tuyuyú	1	-	LC	-
Columbiformes					
Columbidae					
Columbina picui	Tortolita picuí	5	-	LC	-
Columbina squammata	Palomita escamada	3	-	LC	-
Columbina talpacoti	Tortolita colorada	2	-	LC	-
Leptotila verreauxi	Yerutí común	8	-	LC	-
Patagioenas picazuro	Paloma turca	17	-	LC	-
Zenaida auriculata	Torcaza	52	-	LC	-
Coraciiformes					
Alcedinidae					
Chloroceryle amazona	Martín pescador mediano	2	-	LC	-
Megaceryle torquata	Martín pescador grande	1	-	LC	-

Table 5.3.2.4.1.a
List of species recorded during the first birding season

Order/Family/Species	Popular name	Records	Status of Conservation		
			MADES 2019	IUCN 2022	CITES 2023
Cuculiformes					
Cuculidae					
Crotophaga ani	Anó chico	18	-	LC	-
Guira guira	Piririta	16	-	LC	-
Falconiformes					
Falconidae					
Caracara plancus	Carancho	10	-	LC	II
Falco femoralis	Halcón plomizo	5	-	LC	II
Milvago chimachima	Chimachima	6	-	LC	II
Gruiformes					
Aramidae					
Aramus guarauna	Karau	2	-	LC	-
Rallidae					
Aramidas ypecaha	Gallineta de agua	3	-	LC	-
Nyctibiiformes					
Nyctibiidae					
Nyctibius griseus	Urutaú común	1	-	LC	-
Passeriformes					
Corvidae					
Cyanocorax chrysops	Urraca común	6	-	LC	-
Cyanocorax cyanomelas	Urraca morada	6	-	LC	-
Fringillidae					
Eufonía clorótica	Tangará	3	-	LC	-
Furnariidae					
Campylorhamphus trochilirostris	Picapalo colorado	3	-	LC	-
Certhiaxis cinnamomeus	Curutié colorado	2	-	LC	-
Furnarius rufus	Hornero	11	-	LC	-
Lepidocolaptes angustirostris	Chinchero chico	7	-	LC	-
Phacellodomus ruber	Espinero grande	6	-	LC	-

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Table 5.3.2.4.1.a
List of species recorded during the first birding season

Order/Family/Species	Popular name	Records	Status of Conservation		
			MADES 2019	IUCN 2022	CITES 2023
Schoeniophylax phryganophilus	Titisiri	1	-	LC	-
Sittasomus griseicapillus	Guirí	2	-	LC	-
Sinalaxis frontal	Pijuí frente gris	3	-	LC	-
Xiphocolaptes major	Trepador gigante	4	-	LC	-
Hirundinidae					
Progne tapera	Golondrina parda	46	-	LC	-
Icteridae					
Agelaioides badius	Tordo músico	35	-	LC	-
Agelasticus cyanopus	Varillero negro	1	-	LC	-
Cacicus chrysopterus	Boyero ala amarilla	3	-	LC	-
Cacicus solitarius	Boyero negro	2	-	LC	-
Chrysomus ruficapillus	Varillero congo	1	-	LC	-
Gnorimopsar chopi	Chopí	7	-	LC	-
Icterus pyrrhopterus	Boyerito	2	-	LC	-
Molothrus bonariensis	Tordo renegrido	102	-	LC	-
Molothrus rufoaxillaris	Tordo pico corto	6	-	LC	-
Parulidae					
Setophaga pitiayumi	Pitiayumí	1	-	LC	-
Passerellidae					
Arremon flavirostris	Afrechero de collar	3	-	LC	-
Zonotrichia capensis	Bendito Sea	2	-	LC	-
Polypropylidae					
Polioptila dumicola	Tacuarita azul	5	-	LC	-
Thamnophilidae					
Taraba mayor	Chororó	11	-	LC	-
Thamnophilus caerulescens	Batará plomizo	2	-	LC	-
Thamnophilus doliatus	Batará rayado	1	-	LC	-
Thraupidae					
Coryphospingus cucullatus	Brasita de fuego	2	-	LC	-

Table 5.3.2.4.1.a
List of species recorded during the first birding season

Order/Family/Species	Popular name	Records	Status of Conservation		
			MADES 2019	IUCN 2022	CITES 2023
Paroaria capitata	Cardenilla	2	-	LC	II
Paroaria coronata	Cardenal	6	-	LC	II
Saltator coerulescens	Pepitero gris	1	-	LC	-
Sicalis flaveola	Canario paraguay	3	-	LC	-
Tangara sayaca	Chogüí	7	-	LC	-
Tityridae					
Pachyramphus polychopterus	Anambé negro	1	-	LC	-
Pachyramphus viridis	Anambé verde	2	-	LC	-
Troglodytidae					
Campylorhynchus turdinus	Rata grande	3	-	LC	-
Troglodytes aedon	Ratona común	6	-	LC	-
Turdidae					
Turdus amaurochalinus	Zorzal mandioca	2	-	LC	-
Turdus leucomelas	Zorzal alas canelas	1	-	LC	-
Turdus rufiventris	Zorzal colorado	1	-	LC	-
Tiránidos					
Camptostoma obsoletum	Piojito silbón	3	-	LC	-
Casiornis rufus	Suiriri castaño	3	-	LC	-
Elaenia spectabilis	Fiofío grande	1	-	LC	-
Hemitriccus margaritaceiventer	Mosqueta ojo dorado	4	-	LC	-
Machetornis rixosa	Caballerizo	4	-	LC	-
Megarynchus pitangua	Ñei ñei	2	-	LC	-
Myiarchus ferox	Burlisto pico negro	1	-	LC	-
Myiarchus swainsoni	Burlisto pico canela	1	-	LC	-
Myiarchus tyrannulus	Burlisto cola castaña	3	-	LC	-
Myiodynastes maculatus	Pitogüé rayado	4	-	LC	-
Pitangus sulphuratus	Pitogüé común	3	-	LC	-
Serpophaga griseicapilla	Piojito trinador	1	-	LC	-
Suiriri suiriri	Suirirí vientre blanco	1	-	LC	-

Table 5.3.2.4.1.a
List of species recorded during the first birding season

Order/Family/Species	Popular name	Records	Status of Conservation		
			MADES 2019	IUCN 2022	CITES 2023
Tyrannus melancholicus	Suiriri real	3	-	LC	-
Xolmis irupero	Monjita blanca	1	-	LC	-
Vireonidae					
Cyclarhis gujanensis	Juan chiviro	2	-	LC	-
Pelecaniformes					
Ardeidae					
Ardea alba	Garza blanca	2	-	LC	-
Ardea cocoi	Garza mora	3	-	LC	-
Bubulcus ibis	Garcita bueyera	21	-	LC	-
Butorides striata	Garcita azulada	1	-	LC	-
Nycticorax nycticorax	Garza bruja	1	-	LC	-
Syrigma sibilatrix	Garza silbadora	6	-	LC	-
Threskiornithidae					
Phimosus infuscatus	Cuervillo cara pelada	201	-	LC	-
Theristicus caudatus	Bandurria baya	6	-	LC	-
Piciformes					
Picidae					
Campephilus leucopogon	Carpintero lomo blanco	2	-	LC	-
Colaptes campestris	Carpintero campestre	4	-	LC	-
Colaptes melanochloros	Carpintero real	3	-	LC	-
Melanerpes cactorum	Carpintero del cactus	1	-	LC	-
Picumnus cirratus	Carpinterito común	1	-	LC	-
Veniliornis passerinus	Carpinterito oliváceo	1	-	LC	-
Psittaciformes					
Psittacidae					
Amazona aestiva	Loro hablador	6	-	NT	II
Aratinga nenday	Ñanday	36	-	LC	II
Brotogeris chiriri	Catita chiriri	2	-	LC	II
Myiopsitta monachus	Cotorrita	5	-	LC	II

Table 5.3.2.4.1.a
List of species recorded during the first birding season

Order/Family/Species	Popular name	Records	Status of Conservation		
			MADES 2019	IUCN 2022	CITES 2023
Pionus maximiliani	Loro choclero	2	-	LC	II
Psittacara acuticaudatus	Maracaná cabeza azulada	1	-	LC	II
Psittacara leucophthalmus	Maracaná ala roja	2	-	LC	II
Pyrrhura frontalis	Chiripepé cabeza verde	40	-	LC	II
Strigiformes					
Strigidae					
Megascops choliba	Lechucita común	1	-	LC	II
Suliformes					
Phalacrocoracidae					
Nannopterum brasilianus	Cormorán	1	-	LC	-
Tinamiformes					
Tinamidae					
Crypturellus tataupa	Tataupá común	5	-	LC	-
Trogoniformes					
Trogonidae					
Trogon curucui	Suricata aurora	1	-	LC	-
Total		**1037**			

Leyenda Estado de conservación: **LC** - "Preocupación **menor**", **NT** - "Casi amenazada", **Apéndice I - especies amenazadas de extinción cuyo** comercio sólo se permite en circunstancias excepcionales, **Apéndice II** - especies no necesariamente amenazadas de extinción, pero cuyo comercio debe controlarse para evitar usos incompatibles con su supervivencia.

Table 5.3.2.4.1.b
List of species recorded during the second bird conservation season

Order/Family/Species	Popular name	Records	Status of Conservation		
			MADES 2019	UICN 2022	CITES 2023
Accipitriformes					
Accipitridae					
Rostrhamus sociabilis	Caracolero	1	-	LC	II
Rupornis magnirostris	Taguató común	11	-	LC	II
Anseriformes					
Anatidae					
Amazonetta brasiliensis	Patillo	3	-	LC	-
Anhimidae					
Chauna torquata	Chajá	3	-	LC	-
Apodiformes					
Trochilidae					
Chlorostilbon lucidus	Pito real	1	-	LC	II
Heliomaster furcifer	Picaflor de barbijo	1	-	LC	II
Hylocharis chrysura	Picaflor bronceado	3	-	LC	II
Caprimulgiformes					
Caprimulgidae					
Lurocalis semitorquatus	Añapero castaño	1	-	LC	-
Cathartiformes					
Cathartidae					
Cathartes aura	Cuervo cabeza roja	5	-	LC	-
Cathartes burrovianus	Cuervo cabeza amarilla	4	-	LC	-
Coragyps atratus	Cuervo negro	4	-	LC	-
Charadriiformes					
Charadriidae					
Vanellus chilensis	Tero tero	11	-	LC	-
Jacanidae					
Jacana jacana	Jacana	3	-	LC	-

Table 5.3.2.4.1.b
List of species recorded during the second bird conservation season

Order/Family/Species	Popular name	Records	Status of Conservation		
			MADES 2019	UICN 2022	CITES 2023
Laridae					
Sternula superciliaris	Gaviotín chico	4	-	LC	-
Recurvirostridae					
Himantopus himantopus	Tero real	5	-	LC	-
Columbiformes					
Columbidae					
Columbina squammata	Palomita escamosa	7	-	LC	-
Columbina talpacoti	Tortolita de color	3	-	LC	-
Leptotila verreauxi	Yerutí común	7	-	LC	-
Patagioenas picazuro	Paloma turca	103	-	LC	-
Zenaida auriculata	Torcaza	1	-	LC	-
Coraciiformes					
Alcedinidae					
Chloroceryle amazona	Martín pescador mediano	2	-	LC	-
Cuculiformes					
Cuculidae					
Guira guira	Piririta	2	-	LC	-
Tapera naevia	Chochí	4	-	LC	-
Falconiformes					
Falconidae					
Caracara plancus	Carancho	11	-	LC	II
Falco sparverius	Halconcito colorado	2	-	LC	II
Micrastur semitorquatus	Halcón montés	1	-	LC	II
Milvago chimachima	Chimachima	7	-	LC	II
Gruiformes					
Aramidae					
Aramus guarauna	Karau	1	-	LC	-

Table 5.3.2.4.1.b
List of species recorded during the second bird conservation season

Order/Family/Species	Popular name	Records	Status of Conservation		
			MADES 2019	UICN 2022	CITES 2023
Rallidae					
Aramides cajaneus	Chiricoe	5	-	LC	-
Aramidas ypecaha	Gallineta de agua	1	-	LC	-
Passeriformes					
Corvidae					
Cyanocorax chrysops	Urraca común	28	-	LC	-
Cyanocorax cyanomelas	Urraca morada	10	-	LC	-
Fringillidae					
Eufonía clorótica	Tangará	12	-	LC	-
Furnariidae					
Campylorhamphus trochilirostris	Picapalo colorado	5	-	LC	-
Furnarius rufus	Hornero	35	-	LC	-
Lepidocolaptes angustirostris	Chinchero chico	18	-	LC	-
Phacellodomus ruber	Espinero grande	1	-	LC	-
Schoeniophylax phryganophilus	Titisiri	5	-	LC	-
Sinalaxis frontal	Pijuí frente gris	2	-	LC	-
Xiphocolaptes major	Trepador gigante	7	-	LC	-
Icteridae					
Agelaioides badius	Tordo músico	15	-	LC	-
Cacicus chrysopterus	Boyero ala amarilla	10	-	LC	-
Cacicus solitarius	Boyero negro	6	-	LC	-
Chrysomus ruficapillus	Varillero congo	51	-	LC	-
Icterus pyrrhopterus	Boyerito	6	-	LC	-
Molothrus bonariensis	Tordo renegrido	42	-	LC	-
Parulidae					
Setophaga pitiayumi	Pitiayumí	2	-	LC	-
Passerellidae					
Arremon flavirostris	Afrechero de collar	3	-	LC	-

Table 5.3.2.4.1.b
List of species recorded during the second bird conservation season

Order/Family/Species	Popular name	Records	Status of Conservation		
			MADES 2019	UICN 2022	CITES 2023
Zonotrichia capensis	Bendito Sea	1	-	LC	-
Polypropylidae					
Polioptila dumicola	Tacuarita azul	13	-	LC	-
Thamnophilidae					
Taraba mayor	Chororó	4	-	LC	-
Thamnophilus caerulescens	Batará plomizo	2	-	LC	-
Thraupidae					
Coryphospingus cucullatus	Brasita de fuego	3	-	LC	-
Paroaria capitata	Cardenilla	2	-	LC	II
Paroaria coronata	Cardenal	13	-	LC	II
Saltator coerulescens	Pepitero gris	5	-	LC	-
Sicalis flaveola	Canario paraguay	1	-	LC	-
Tachyphonus rufus	Frutero negro	6	-	LC	-
Tangara sayaca	Chogüí	11	-	LC	-
Troglodytidae					
Campylorhynchus turdinus	Ratona grande	41	-	LC	-
Troglodytes aedon	Ratona común	18	-	LC	-
Turdidae					
Turdus amaurochalinus	Zorzal mandioca	5	-	LC	-
Turdus leucomelas	Zorzal alas canelas	1	-	LC	-
Turdus rufiventris	Zorzal colorado	2	-	LC	-
Tiránidos					
Camptostoma obsoletum	Piojito silbón	6	-	LC	-
Casiornis rufus	Suiriri castaño	2	-	LC	-
Hemitriccus margaritaceiventer	Mosqueta ojo dorado	1	-	LC	-
Machetornis rixosa	Caballerizo	2	-	LC	-
Myiarchus tyrannulus	Burlisto cola castaña	4	-	LC	-
Pitangus sulphuratus	Pitogüé común	20	-	LC	-

Table 5.3.2.4.1.b

List of species recorded during the second bird conservation season

Order/Family/Species	Popular name	Records	Status of Conservation		
			MADES 2019	UICN 2022	CITES 2023
Pyrocephalus rubinus	Churrinche	2	-	LC	-
Tyrannus melancholicus	Suiriri real	2	-	LC	-
Vireonidae					
Cyclarhis gujanensis	Juan chiviro	7	-	LC	-
Pelecaniformes					
Ardeidae					
Ardea alba	Garza blanca	64	-	LC	-
Egretta thula	Garcita blanca	19	-	LC	-
Syrigma sibilatrix	Garza silbadora	13	-	LC	-
Tigrisoma lineatum	Hocó colorado	1	-	LC	-
Threskiornithidae					
Phimosus infuscatus	Cuervillo cara pelada	135	-	LC	-
Platalea ajaja	Espátula rosada	12	-	LC	-
Plegadis chihi	Cuervillo de cañada	16	-	LC	-
Theristicus caudatus	Bandurria baya	3	-	LC	-
Piciformes					
Picidae					
Campephilus leucopogon	Carpintero lomo blanco	4	-	LC	-
Colaptes melanochloros	Carpintero real	2	-	LC	-
Melanerpes cactorum	Carpintero del cactus	3	-	LC	-
Melanerpes candidus	Carpintero blanco	9	-	LC	-
Piculus chrysochloros	Carpintero dorado	1	-	LC	-
Picumnus cirratus	Carpinterito común	4	-	LC	-
Veniliornis mixtus	Carpintero bataraz	2	-	LC	-
Veniliornis passerinus	Carpinterito oliváceo	1	-	LC	-
Psittaciformes					
Psittacidae					
Amazona aestiva	Loro hablador	8	-	NT	II

Table 5.3.2.4.1.b
List of species recorded during the second bird conservation season

Order/Family/Species	Popular name	Records	Status of Conservation		
			MADES 2019	UICN 2022	CITES 2023
Aratinga nenday	Ñanday	50	-	LC	II
Brotogeris chiriri	Catita chiriri	24	-	LC	II
Forpus xanthopterygius	Catita viuda	4	-	LC	II
Myiopsitta monachus	Cotorrita	6	-	LC	II
Pionus maximiliani	Loro choclero	7	-	LC	II
Psittacara acuticaudatus	Maracaná cabeza azulada	6	-	LC	II
Psittacara leucophthalmus	Maracaná ala roja	4	-	LC	II
Pyrrhura frontalis	Chiripepé cabeza verde	53	-	LC	II
Tinamiformes					
Tinamidae					
Crypturellus tataupa	Tataupá común	3	-	LC	-
Total		**1103**			

Legend Conservation Status: **LC** - "Little Concern, **NT** - "Near Threatened", **Apendix II -** Species not necessarily threatened with extinction, but whose trade must be controlled to avoid uses incompatible with its survival.

Table 5.3.2.4.1.c
List of species recorded during bird survey campaigns and through secondary data (AII)

Order/Family/Species	Popular name	Campaign		Total	AII	Status of conservation				State of residence	Endemism	Cynegetic	Inserted	Invasive Exotics	Invasive Native	Aquatic	Grasslands	Sensitivity
		1C	2C			MADES 2019	UICN 2022	CITES 2023	CMS 2022									
Accipitriformes																		
Accipitridae																		
Busarellus nigricollis	gavilán de estero				X	-	LC	II	-	R	-	-	-	-	-	-	-	L
Rostrhamus sociabilis	caracolero	1	1	2	X	-	LC	II	II	AS	-	-	-	-	-	-	-	L
Rupornis magnirostris	taguató común	4	11	15	X	-	LC	II	-	R	-	-	-	-	-	-	-	L
Elanidae																		
Gampsonyx swainsonii	milano chico				X	-	LC	II	-	R	-	-	-	-	-	-	-	L
Pandionidae																		
Pandion haliaetus	águila pescadora				X	-	LC	II	II	N	-	-	-	-	-	-	-	M
Anseriformes																		
Anatidae																		
Amazonetta brasiliensis	patillo	1	3	4	X	-	LC	-	-	R	-	A	-	-	-	X	-	L
Cairina moschata	bragado	8		8	X	-	LC	-	-	R	-	A	-	-	-	X	-	M
Dendrocygna autumnalis	pato silbón ala blanca	53		53	X	-	LC	-	-	R	-	A	-	-	-	X	-	L
Dendrocygna viduata	pato silbón cara blanca	1		1	X	-	LC	-	-	R	-	A	-	-	-	X	-	L
Anhimidae																		
Chauna torquata	chajá	2	3	5	X	-	LC	-	-	R	-	A	-	-	-	X	-	L
Apodiformes																		
Trochilidae																		
Chlorostilbon lucidus	picaflor verde	1	1	2	X	-	LC	II	-	R	-	-	-	-	-	-	-	L
Heliomaster furcifer	picaflor de barbijo	1	1	2	X	-	LC	II	-	R	-	-	-	-	-	-	-	M
Hylocharis chrysura	picaflor bronceado	3	3	6	X	-	LC	II	-	R	-	-	-	-	-	-	-	M
Polytmus guainumbi	picaflor de antifaz				X	-	LC	II	-	R	-	-	-	-	-	-	O	M
Caprimulgiformes																		
Caprimulgidae																		
Chordeiles menores	añapero boreal				X	-	LC	-	-	N	-	-	-	-	-	-	-	L
Chordeiles nacunda	ñacundá				X	-	LC	-	-	AS	-	-	-	-	-	-	F	L
Lurocalis semitorquatus	añapero castaño	1	1	2	X	-	LC	-	-	AN,R?	-	-	-	-	-	-	-	M
Nyctidromus albicollis	curiango				X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Cariamiformes																		
Cariamidae																		
Cariama cristata	saría patas rojas	1		1	X	-	LC	-	-	R	-	-	-	-	-	-	F	M
Cathartiformes																		
Cathartidae																		
Cathartes aura	cuervo cabeza roja		5	5	X	-	LC	-	-	R	-	-	-	-	-	-	F	L
Cathartes burrovianus	cuervo cabeza amarilla	1	4	5	X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Coragyps atratus	cuervo negro	35	4	39	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Charadriiformes																		
Charadriidae																		
Charadrius collaris	chorlito de collar				X	-	LC	-	-	R	-	-	-	-	-	X	-	H
Vanellus chilensis	tero tero	12	11	23	X	-	LC	-	-	R	-	-	-	-	-	X	O	L
Jacanidae																		
Jacana jacana	jacana	3	3	6	X	-	LC	-	-	R	-	-	-	-	-	X	-	L
Laridae																		
Phaetusa simplex	atí	1		1	X	-	LC	-	-	R	-	-	-	-	-	X	-	H
Rynchops niger	rayador				X	-	LC	-	-	R	-	-	-	-	-	X	-	H
Sternula superciliaris	gaviotín chico		4	4	X	-	LC	-	-	R	-	-	-	-	-	X	-	H
Recurvirostridae																		
Himantopus himantopus	tero real		5	5		-	LC	-	-	R	-	-	-	-	-	X	-	M
Scolopacidae																		

Table 5.3.2.4.1.c
List of species recorded during bird survey campaigns and through secondary data (AII)

Order/Family/Species	Popular name	Campaign		Total	All	Status of conservation				State of residence	Endemism	Cynegetic	Inserted	Invasive Exotics	Invasive Native	Aquatic	Grasslands	Sensitivity
		1C	2C			MADES 2019	UICN 2022	CITES 2023	CMS 2022									
Actitis macularius	playerito manchado				X	-	LC	-	II	N	-	-	-	-	-	X	-	L
Gallinago paraguaiae	becasina chica				X	-	LC	-	-	R	-	-	-	-	-	X	O	L
Tringa solitaria	pitotoi solitario	5		5	X	-	LC	-	II	N	-	-	-	-	-	X	-	L
Ciconiiformes																		
Ciconiidae																		
Ciconia maguari	cigüeña americana	1		1	X	-	LC	-	-	R	-	-	-	-	-	X	-	L
Jabiru mycteria	yabirú	37		37	X	-	LC	I	-	R	-	-	-	-	-	X	-	M
Mycteria americana	tuyuyú	1		1	X	-	LC	-	-	R	-	-	-	-	-	X	-	L
Columbiformes																		
Columbidae																		
Columba livia	paloma doméstica				X	-	LC	-	-	C1	-	-	X	-	-	-	-	L
Columbina picui	tortolita picuí	5		5	X	-	LC	-	-	R	-	A	-	-	-	-	-	L
Columbina squammata	palomita escamada	3	7	10	X	-	LC	-	-	R	-	A	-	-	-	-	-	L
Columbina talpacoti	tortolita colorada	2	3	5	X	-	LC	-	-	R	-	A	-	-	-	-	-	L
Leptotila verreauxi	yerutí común	8	7	15	X	-	LC	-	-	R	-	A	-	-	-	-	-	L
Patagioenas picazuro	paloma turca	17	103	120	X	-	LC	-	-	AS	-	A	-	-	-	-	F	M
Zenaida auriculata	torcaza	52	1	53	X	-	LC	-	-	R	-	A	-	-	-	-	F	L
Coraciiformes																		
Alcedinidae																		
Chloroceryle amazona	martín pescador mediano	2	2	4	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Chloroceryle americana	martín pescador chico				X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Megaceryle torquata	martín pescador grande	1		1	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Cuculiformes																		
Cuculidae																		
Crotophaga ani	anó chico	18		18	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Crotophaga major	anó grande				X	-	LC	-	-	AN	-	-	-	-	-	-	-	M
Guira guira	piririta	16	2	18	X	-	LC	-	-	R	-	-	-	-	-	-	F	L
Tapera naevia	chochí		4	4	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Falconiformes																		
Falconidae																		
Caracara plancus	carancho	10	11	21	X	-	LC	II	-	R	-	-	-	-	-	-	F	L
Falco femoralis	halcón plomizo	5		5	X	-	LC	II	-	R	-	-	-	-	-	-	O	L
Falco sparverius	halconcito colorado		2	2	X	-	LC	II	-	R	-	-	-	-	-	-	F	L
Micrastur semitorquatus	halcón montés		1	1		-	LC	II	-	R	-	-	-	-	-	-	-	M
Milvago chimachima	chimachima	6	7	13	X	-	LC	II	-	R	-	-	-	-	-	-	-	L
Galliformes																		
Cracidae																		
Ortalis canicollis	charata				X	-	LC	-	-	R	CHA	-	-	-	-	-	-	L

Table 5.3.2.4.1.c
List of species recorded during bird survey campaigns and through secondary data (All)

Order/Family/Species	Popular name	Campaign		Total	All	Status of conservation				State of residence	Endemism	Cynegetic	Inserted	Invasive Exotics	Invasive Native	Aquatic	Grasslands	Sensitivity
		1C	2C			MADES 2019	UICN 2022	CITES 2023	CMS 2022									
Gruiformes																		
Aramidae																		
Aramus guarauna	carau	2	1	3	X	-	LC	-	-	R	-	-	-	-	-	X	-	M
Rallidae																		
Aramides cajaneus	chiricoe		5	5		-	LC	-	-	R	-	-	-	-	-	X	-	H
Aramidas ypecaha	gallineta de agua	3	1	4	X	-	LC	-	-	R	-	-	-	-	-	X	-	M
Porzana albicollis	burrito grande				X	-	LC	-	-	R	-	-	-	-	-	X	-	M
Nyctibiiformes																		
Nyctibiidae																		
Nyctibius griseus	urutaú común	1		1	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Passeriformes																		
Corvidae																		
Cyanocorax chrysops	urraca común	6	28	34	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Cyanocorax cyanomelas	urraca morada	6	10	16	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Donacobiidae																		
Donacobius atricapilla	angú				X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Fringillidae																		
Eufonía clorótica	tangará	3	12	15	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Spinus magellanicus	cabecita negra				X	-	LC	-	-	R	-	-	-	-	-	-	F	L
Furnariidae																		
Anumbius annumbius	leñatero				X	-	LC	-	-	R	-	-	-	-	-	-	F	M
Campylorhamphus trochilirostris	picapalo colorado	3	5	8	X	-	LC	-	-	R	-	-	-	-	-	-	-	H
Certhiaxis cinnamomeus	curutié colorado	2		2	X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Furnarius rufus	hornero	11	35	46	X	-	LC	-	-	R	-	-	-	-	-	-	F	L
Lepidocolaptes angustirostris	chinchero chico	7	18	25	X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Phacellodomus ruber	espinero grande	6	1	7	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Schoeniophylax phryganophilus	titisiri	1	5	6	X	-	LC	-	-	R	-	-	-	-	-	-	F	L
Sittasomus griseicapillus	guirí	2		2	X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Sinalaxis frontal	pijuí frente gris	3	2	5	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Xiphocolaptes major	trepador gigante	4	7	11	X	-	LC	-	-	R	CHA	-	-	-	-	-	-	M
Hirundinidae																		
Hirundo rustica	golondrina tijerita				X	-	LC	-	-	N	-	-	-	-	-	-	F	L
Petrochelidon pyrrhonota	golondrina rabadilla canela				X	-	LC	-	-	N	-	-	-	-	-	-	F	L
Progne chalybea	golondrina doméstica				X	-	LC	-	-	AN	-	-	-	-	-	-	-	L
Progne tapera	golondrina parda	46		46	X	-	LC	-	-	AN	-	-	-	-	-	-	F	L
Stelgidopteryx ruficollis	golondrina ribereña				X	-	LC	-	-	AN	-	-	-	-	-	-	-	L
Icteridae																		
Agelaioides badius	tordo músico	35	15	50	X	-	LC	-	-	R	-	O	-	-	-	-	F	L
Agelasticus cyanopus	varillero negro	1		1	X	-	LC	-	-	R	-	O	-	-	-	-	-	M
Amblyramphus holosericeus	federal				X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Cacicus chrysopterus	boyero ala amarilla	3	10	13	X	-	LC	-	-	R	-	O	-	-	-	-	-	L
Cacicus solitarius	boyero negro	2	6	8	X	-	LC	-	-	R	-	O	-	-	-	-	-	M
Chrysomus ruficapillus	varillero congo	1	51	52	X	-	LC	-	-	R	-	O	-	-	-	-	-	L
Gnorimopsar chopi	chopí	7		7	X	-	LC	-	-	R	-	O	-	-	-	-	F	L
Icterus pyrrhopterus	boyerito	2	6	8	X	-	LC	-	-	R	-	O	-	-	-	-	-	M
Molothrus bonariensis	tordo renegrido	102	42	144	X	-	LC	-	-	R	-	O	-	-	X	-	F	L
Molothrus rufoaxillaris	tordo pico corto	6		6	X	-	LC	-	-	R	-	O	-	-	-	-	F	L
Pseudoleistes guirahuro	chopí estero				X	-	LC	-	-	R	-	-	-	-	-	-	O	L
Mimidae																		

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		1C	2C			MADES 2019	UICN 2022	CITES 2023	CMS 2022									
Mimus saturninus	calandria grande				X	-	LC	-	-	R	-	-	-	-	-	-	F	L
Motacillidae																		
Anthus lutescens	cachirla chica				X	-	LC	-	-	R	-	-	-	-	-	-	O	L
Parulidae																		
Basileuterus culicivorus	arañero coronado				X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Setophaga pitiayumi	pitiayumí	1	2	3	X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Passerellidae																		
Ammodramus humeralis	cachilo ceja amarilla				X	-	LC	-	-	R	-	-	-	-	-	-	O	L
Arremon flavirostris	afrechero de collar	3	3	6	X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Zonotrichia capensis	bendito sea	2	1	3	X	-	LC	-	-	R	-	-	-	-	-	-	F	L
Passeridae																		
Passer domesticus	Corbatita				X	-	LC	-	-	C1	-	-	X	-	-	-	-	L
Polypropylidae																		
Polioptila dumicola	tacuarita azul	5	13	18	X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Thamnophilidae																		
Taraba mayor	chororó	11	4	15	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Thamnophilus caerulescens	batará plomizo	2	2	4	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Thamnophilus doliatus	batará rayado	1		1	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Thraupidae																		
Coryphospingus cucullatus	brasita de fuego	2	3	5	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Emberizoides herbicola	coludo grande				X	-	LC	-	-	R	-	-	-	-	-	-	O	L
Embernagra platensis	verdón				X	-	LC	-	-	R	-	-	-	-	-	-	O	L
Paroaria capitata	cardenilla	2	2	4	X	-	LC	II	-	R	-	O	-	-	-	-	-	L
Paroaria coronata	cardenal	6	13	19	X	-	LC	II	-	R	-	O	-	-	-	-	F	L
Saltator coerulescens	pepitero gris	1	5	6	X	-	LC	-	-	R	-	O	-	-	-	-	-	L
Sicalis flaveola	canario paraguay	3	1	4	X	-	LC	-	-	R	-	O	-	-	-	-	-	L
Sporophila angolensis	curió				X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Sporophila caerulescens	corbatita común				X	-	LC	-	-	R	-	-	-	-	-	-	F	L
Sporophila collaris	corbatita dominó				X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Sporophila hypoxantha	capuchino canela				X	-	LC	-	-	R	-	-	-	-	-	-	O	M
Sporophila leucoptera	corbatita blanco				X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Tachyphonus rufus	frutero negro		6	6	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Tangara sayaca	chogüí	7	11	18	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Volatinia jacarina	volatinero				X	-	LC	-	-	R	-	-	-	-	-	-	F	L
Tityridae																		
Pachyramphus polychopterus	anambé negro	1		1	X	-	LC	-	-	AN	-	-	-	-	-	-	-	L
Pachyramphus viridis	anambé verdoso	2		2	X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Troglodytidae																		
Campylorhynchus turdinus	ratona grande	3	41	44	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Troglodytes aedon	ratona común	6	18	24	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Turdidae																		
Turdus amaurochalinus	zorzal mandioca	2	5	7	X	-	LC	-	-	R	-	O	-	-	-	-	F	L
Turdus leucomelas	zorzal alas canelas	1	1	2	X	-	LC	-	-	R	-	O	-	-	-	-	-	L
Turdus rufiventris	zorzal colorado	1	2	3	X	-	LC	-	-	R	-	O	-	-	-	-	-	L
Tiránidos																		
Alectrurus risora	yetapá de collar				X	ES	VU	-	I	R	-	-	-	-	-	-	F	M
Arundinicola leucocephala	lavandera				X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Camptostoma obsoletum	piojito silbón	3	6	9	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Casiornis rufus	suiriri castaño	3	2	5	X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Cnemotriccus fuscatus	mosqueta ceja blanca				X	-	LC	-	-	AN	-	-	-	-	-	-	-	L

Table 5.3.2.4.1.c
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		1C	2C			MADES 2019	UICN 2022	CITES 2023	CMS 2022									
Elaenia spectabilis	fiofío grande	1		1	X	-	LC	-	-	AN	-	-	-	-	-	-	-	L
Fluvicola albiventer	viudita blanca				X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Hemitriccus margaritaceiventer	mosqueta ojo dorado	4	1	5	X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Hymenops perspicillatus	pico de plata				X	-	LC	-	-	AS	-	-	-	-	-	-	F	M
Knipolegus cyanirostris	viudita pico celeste				X	-	LC	-	-	AV	-	-	-	-	-	-	-	L
Machetornis rixosa	caballerizo	4	2	6	X	-	LC	-	-	R	-	-	-	-	-	-	F	L
Megarynchus pitangua	ñei ñei	2		2	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Myiarchus ferox	burlisto pico negro	1		1	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Myiarchus swainsoni	burlisto pico canela	1		1	X	-	LC	-	-	AN	-	-	-	-	-	-	-	L
Myiarchus tyrannulus	burlisto cola castaña	3	4	7	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Myiodynastes maculatus	pitogüé rayado	4		4	X	-	LC	-	-	AN	-	-	-	-	-	-	-	L
Myiopagis viridicata	fiofío corona dorada				X	-	LC	-	-	AN	-	-	-	-	-	-	-	M
Pitangus sulphuratus	pitogüé común	3	20	23	X	-	LC	-	-	R	-	-	-	-	-	-	F	L
Pyrocephalus rubinus	churrinche		2	2	X	-	LC	-	-	AS	-	-	-	-	-	-	F	L
Satrapa icterophrys	suirirí amarillo				X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Serpophaga griseicapilla	piojito trinador	1		1	X	-	LC	-	-	AV	-	-	-	-	-	-	-	L
Suiriri suiriri	suirirí vientre blanco	1		1	X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Tolmomyias sulphurescens	picochato grande				X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Tyrannus melancholicus	suiriri real	3	2	5	X	-	LC	-	-	AN	-	-	-	-	-	-	F	L
Tyrannus savana	tijereta				X	-	LC	-	-	AN	-	-	-	-	-	-	O	L
Xolmis cinereus	monjita gris				X	-	LC	-	-	R	-	-	-	-	-	-	F	L
Xolmis irupero	monjita blanca	1		1	X	-	LC	-	-	R	-	-	-	-	-	-	F	L
Vireonidae																		
Cyclarhis gujanensis	juan chiviro	2	7	9	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Pelecaniformes																		
Ardeidae																		
Ardea alba	garza blanca	2	64	66	X	-	LC	-	-	R	-	-	-	-	-	X	-	L
Ardea cocoi	garza mora	3		3	X	-	LC	-	-	R	-	-	-	-	-	X	-	L
Bubulcus ibis	garcita bueyera	21		21	X	-	LC	-	-	R	-	-	-	X	-	X	F	L
Butorides striata	garcita azulada	1		1	X	-	LC	-	-	R	-	-	-	-	-	X	-	L
Egretta thula	garcita blanca		19	19	X	-	LC	-	-	R	-	-	-	-	-	X	-	L
Nycticorax nycticorax	garza bruja	1		1	X	-	LC	-	-	R	-	-	-	-	-	X	-	L
Syrigma sibilatrix	garza silbadora	6	13	19	X	-	LC	-	-	R	-	-	-	-	-	X	F	M
Tigrisoma lineatum	hocó colorado		1	1	X	-	LC	-	-	R	-	-	-	-	-	X	-	M
Threskiornithidae																		
Mesembrinibis cayennensis	tapicurú				X	-	LC	-	-	R	-	-	-	-	-	X	-	M
Phimosus infuscatus	cuervillo cara pelada	201	135	336	X	-	LC	-	-	R	-	-	-	-	-	X	-	M
Platalea ajaja	espátula rosada		12	12		-	LC	-	-	R	-	-	-	-	-	X	-	M
Plegadis chihi	cuervillo de cañada		16	16		-	LC	-	-	R	-	-	-	-	-	X	-	L
Theristicus caudatus	bandurria baya	6	3	9	X	-	LC	-	-	R	-	-	-	-	-	X	F	L
Piciformes																		
Picidae																		
Campephilus leucopogon	carpintero lomo blanco	2	4	6	X	-	LC	-	-	R	CHA	-	-	-	-	-	-	M
Celeus lugubris	carpintero copete pajizo				X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Colaptes campestris	carpintero campestre	4		4	X	-	LC	-	-	R	-	-	-	-	-	-	F	L
Colaptes melanochloros	carpintero real	3	2	5	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Melanerpes cactorum	carpintero del cactus	1	3	4	X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Melanerpes candidus	carpintero blanco		9	9		-	LC	-	-	R	-	-	-	-	-	-	-	L
Piculus chrysochloros	carpintero dorado		1	1		-	LC	-	-	R	-	-	-	-	-	-	-	M
Picumnus cirratus	carpinterito común	1	4	5	X	-	LC	-	-	R	-	-	-	-	-	-	-	L

Table 5.3.2.4.1.c
List of species recorded during bird survey campaigns and through secondary data (All)

Order/Family/Species	Popular name	Campaign		Total	All	Status of conservation				State of residence	Endemism	Cynegetic	Inserted	Invasive Exotics	Invasive Native	Aquatic	Grasslands	Sensitivity
		1C	2C			MADES 2019	UICN 2022	CITES 2023	CMS 2022									
Veniliornis mixtus	carpintero bataraz		2	2	X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Veniliornis passerinus	carpinterito oliváceo	1	1	2	X	-	LC	-	-	R	-	-	-	-	-	-	-	L
Psittaciformes																		
Psittacidae																		
Amazona aestiva	loro hablador	6	8	14	X	-	NT	II	-	R	-	O	-	-	-	-	-	M
Aratinga nenday	ñanday	36	50	86	X	-	LC	II	-	R	-	O	-	-	-	-	-	M
Brotogeris chiriri	catita chiriri	2	24	26	X	-	LC	II	-	R	-	O	-	-	-	-	-	M
Forpus xanthopterygius	catita viuda		4	4	X	-	LC	II	-	R	-	O	-	-	-	-	-	L
Myiopsitta monachus	cotorrita	5	6	11	X	-	LC	II	-	R	-	O	-	-	-	-	F	L
Pionus maximiliani	loro choclero	2	7	9	X	-	LC	II	-	R	-	O	-	-	-	-	-	M
Psittacara acuticaudatus	maracaná cabeza azulada	1	6	7	X	-	LC	II	-	R	-	O	-	-	-	-	-	M
Psittacara leucophthalmus	maracaná ala roja	2	4	6	X	-	LC	II	-	R	-	O	-	-	-	-	-	L
Pyrrhura frontalis	chiripepé cabeza verde	40	53	93	X	-	LC	II	-	R	ATL	O	-	-	-	-	-	M
Strigiformes																		
Strigidae																		
Athene cunicularia	lechucita vizcachera				X	-	LC	II	-	R	-	-	-	-	-	-	O	M
Glaucidium brasilianum	caburé				X	-	LC	II	-	R	-	-	-	-	-	-	-	L
Megascops choliba	lechucita común	1		1	X	-	LC	II	-	R	-	-	-	-	-	-	-	L
Tytonidae																		
Tyto alba	lechuza de campanario				X	-	LC	II	-	R	-	-	-	-	-	-	-	L
Suliformes																		
Anhingidae																		
Anhinga anhinga	aninga				X	-	LC	-	-	R	-	-	-	-	-	X	-	M
Phalacrocoracidae																		
Nannopterum brasilianus	cormorán	1		1	X	-	LC	-	-	R	-	-	-	-	-	X	-	L
Tinamiformes																		
Tinamidae																		
Crypturellus tataupa	tataupá común	5	3	8	X	-	LC	-	-	R	-	A	-	-	-	-	-	L
Nothura maculosa	perdiz chica				X	-	LC	-	-	R	-	-	-	-	-	-	O	L
Rhynchotus rufescens	martineta				X	-	LC	-	-	R	-	-	-	-	-	-	O	L
Trogoniformes																		
Trogonidae																		
Trogon curucui	surucuá aurora	1		1	X	-	LC	-	-	R	-	-	-	-	-	-	-	M
Total general		**1037**	**1103**	**2140**														

Legend: Conservation Status: (MADES, 2019 and UICN 2022) **LC** - "Low Concern", **NT** - "Near Threatened", **VU** - "Vulnerable", **EN** - "Endangered". (CITES 2023) **Appendix I** - endangered species whose trade is only allowed in exceptional circumstances, **Appendix II** - species that are not necessarily threatened with extinction, but whose trade must be controlled to avoid uses incompatible with their survival; (CMS) **Appendix I - Endangered migratory species**, **Appendix II** - Migratory species in an unfavourable conservation status that should be the subject of international agreements; Residency Status (DEL CASTILLO & CLAY 2005): **R** - Permanent Nesting Resident, year-round breeder, **N** - Nearctic Migrator, **V** - Vacationer, It does not nest but is present in its breeding season, **NA** - Northern southern migrant, nests and migrates north, **AS** - Southern Migrant Nesting Swelling Ramp Increase in Winter, **AV** – Winter visitor, does not nest, **AT** – Transitory species, does not nest, **I** - Intratropical migrant, does not nest, **E** – Wandering or rambling , **NOM** - Nomadic Migrant, **?** – Unknown status, **C1** - Inserted; Endemism: **ATL** – Atlantic Forest, **CHA** - Chaco; Hunting: **A – Cynegetic species used for consumption**, **O** - Synegetic species intended for ornamentation; Grasslands: **O** - Obligatory; **F** - Facultative; Sensitivity: **H** –*High*, **M** –*Medium*, **L** –*Low*.

Lists of Herpetofauna Species

Table 5.3.2.3.2.a
List of species recorded during the first and second herpetofauna survey campaigns

CLASS/ Order/Family/Species	Popular name	Campaign		Status of Conservation			End.
		1C	2C	IUCN (2022)	CITES (2023)	MADES (2019, 2020)	
Amphibia							
Anura							
Bufonidae							
Rhinella azarai	Sapito, Kururu	x	5	-	-	-	-
Rhinella diptycha	Sapo, Kururu	x	1	DD	-	-	W
Hylidae							
Boana raniceps	Rana del zarzal, Ju'i pakova	x	1	LC	-	-	W
Dendropsophus minutus	Rana enana, Ju'i	x		LC	-	-	W
Dendropsophus nanus	Rana enana, Ju'i	x		LC	-	-	W
Scinax acuminatus	Rana de pileta, Ju'i letrina		3	LC	-	-	-
Scinax fuscovarius	Rana de pileta, Ju'i letrina		1	LC	-	-	W
Scinax nasicus	Rana de pileta, Ju'i letrina	x		LC	-	-	W
Leptodactylidae							
Adenomera diptyx	Rana, Ju'i	x		LC	-	-	-
Leptodactylus elenae	Rana, Ju'i	x		LC	-	-	-
Leptodactylus fuscus	Rana, Ju'i	x		LC	-	-	W
Leptodactylus latinasus	Rana, Ju'i	x	3	LC	-	-	-
Leptodactylus latrans	Rana, Ju'i	x		LC	-	-	W
Leptodactylus macrosternum	Rana, Ju'i	x	1	-	-	-	-
Leptodactylus mystacinus	Rana, Ju'i	x		LC	-	-	W
Leptodactylus podicipinus	Rana, Ju'i	x	1	LC	-	-	W
Physalaemus cuvieri	Rana, Ju'i	x		LC	-	-	W
Physalaemus sp.1	Rana, Ju'i		2	-	-	-	-
Physalaemus sp.2	Rana, Ju'i		1				
Pseudopaludicola boliviana	Rana, Ju'i	x	4	LC	-	-	-

Table 5.3.2.3.2.a
List of species recorded during the first and second herpetofauna survey campaigns

CLASS/ Order/Family/Species	Popular name	Campaign		Status of Conservation			End.
		1C	2C	IUCN (2022)	CITES (2023)	MADES (2019, 2020)	
Odontophrynidae							
Odontophrynus americanus			3	LC	-	-	-
Reptilia							
Squamata (Lagartos)							
Teiidae							
Salvator merianae	Lagarto overo, Teju guasu	x		LC	II	-	-
Squamata (Serpentes)							
Colubridae							
Drymarchon corais	Culebra	x		LC	-	-	W
Dipsadidae							
Dryophylax chaquensis	Ojo de gato, Mboi capi'i	x	1	-	-	-	-
Erythrolamprus almadensis	Falsa yarará	x		LC	-	-	W
Erythrolamprus poecilogyrus	Culebra, Mboi capitán		2	LC	-	-	W
Hydrodynastes gigas	Ñacaniná		1	LC	-	-	W

Legend: Conservation Status: DD – Insuficient data, LC - "Low Concern". Endemism: W – Large distribution.

Table 5.3.2.3.2.c
List of species recorded during herpetofauna survey campaigns and secondary data (AII)

Order/Family/*Species*	Popular name	Campaign		Total	AII	Status of Conservation			End.
		1C	2C			IUCN (2022)	CITES (2023)	MADES (2019, 2020)	
Anura									
Amphibia									
Bufonidae			6	6					
Rhinella azarai	Sapito, Kururu	X	5	5	X	-	-	-	-
Rhinella diptycha	Sapo, Kururu	X	1	1	X	DD	-	-	W
Hylidae									
Boana punctata	Rana punteada, Ju'i				X	LC	-	-	W
Boana raniceps	Rana del zarzal, Ju'i pakova		1	1	X	LC	-	-	W
Dendropsophus minutus	Rana enana, Ju'i	X			X	LC	-	-	W
Dendropsophus nanus	Rana enana, Ju'i	X			X	LC	-	-	W
Lysapsus limellum	Rana boyadora, Ju'i				X	LC	-	-	-
Scinax acuminatus	Rana de pileta, Ju'i letrina		3	3	X	LC	-	-	-
Scinax fuscovarius	Rana de pileta, Ju'i letrina		1	1	X	LC	-	-	W
Scinax nasicus	Rana de pileta, Ju'i letrina	X			X	LC	-	-	W
Trachycephalus typhonius	Rana lechera, Ju'i nekere				X	LC	-	-	-
Leptodactylidae									
Adenomera diptyx	Rana, Ju'i	X			X	LC	-	-	-
Leptodactylus bufonius	Rana, Ju'i				X	LC	-	-	-
Leptodactylus elenae	Rana, Ju'i	X			X	LC	-	-	-
Leptodactylus fuscus	Rana, Ju'i	X			X	LC	-	-	W
Leptodactylus gracilis	Rana, Ju'i				X	LC	-	-	-
Leptodactylus latinasus	Rana, Ju'i	X	3	3		LC	-	-	-
Leptodactylus latrans	Rana, Ju'i	X				LC	-	-	W
Leptodactylus luctator	Rana criolla, Ju'i				X	-	-	-	-
Leptodactylus macrosternum	Rana, Ju'i	X	1	1	X	-	-	-	-
Leptodactylus mystacinus	Rana, Ju'i	X			X	LC	-	-	W
Leptodactylus podicipinus	Rana, Ju'i	X	1	1	X	LC	-	-	W

Table 5.3.2.3.2.c
List of species recorded during herpetofauna survey campaigns and secondary data (AII)

Order/Family/*Species*	Popular name	Campaign		Total	AII	Status of Conservation			End.
		1C	2C			IUCN (2022)	CITES (2023)	MADES (2019, 2020)	
Physalaemus albonotatus	Rana, Ju'i vakara'y				X	LC	-	-	-
Physalaemus biligonigerus	Rana cuatro ojos, Ju'i vakara'y				X	LC	-	-	-
Physalaemus cuvieri	Rana, Ju'i	X			X	LC	-	-	W
Physalaemus sp.1	Rana, Ju'i		2	2		LC	-	-	-
Physalaemus sp.2	Rana, Ju'i		1	1					
Pseudopaludicola boliviana	Ranita, Ju'i	X	4	4	X	LC	-	-	-
Microhylidae									
Dermatonotus muelleri	Escuercito, Ju'i				X	LC	-	-	W
Elachistocleis bicolor	Rana aceituna, Ju'i				X	LC	-	-	-
Odontophrynidae									
Odontophrynus americanus			3	3	X	LC	-	-	-
Phyllomedusidae									
Pithecopus azureus	Rana monito, Ju'i pakova				X	DD	-	-	W
Squamata (Lagartos)									
Reptilia									
Amphisbaenidae									
Amphisbaena alba	Culebra, Yvy'ja				X	LC	-	-	W
Diploglossidae									
Ophiodes intermedius	Lagarto, Mboi pepe				X			-	
Gymnophthalmidae									
Cercosaura schreibersii	Lagartija, Tju'i				X	LC	-	-	-
Mabuyidae									
Notomabuya frenata	Lagartija, Ambere				X	LC	-	-	-
Polychrotidae									
Polychrus acutirostris	Falso camaleón, Teju tara				X	LC	-	-	-
Teiidae									
Ameiva ameiva	Lagartija, Teju asaje				X	LC	-	-	-

Table 5.3.2.3.2.c
List of species recorded during herpetofauna survey campaigns and secondary data (AII)

Order/Family/*Species*	Popular name	Campaign		Total	AII	Status of Conservation			End.
		1C	2C			IUCN (2022)	CITES (2023)	MADES (2019, 2020)	
Salvator merianae	Lagarto overo, Teju guasu	X			X	LC	II	-	-
Squamata (Serpentes)									
Reptilia									
Boidae									
Eunectes notaeus	Anaconda amarilla, Kuriju				X	LC	II	-	W
Colubridae									
Drymarchon corais		X			X	LC	-	-	W
Leptophis ahaetulla	Culebra, Mboi hovy				X	LC	-	-	W
Dipsadidae									
Dipsas turgida	Culebra, Ñandurire				X	-	-	-	W
Dipsas ventrimaculata	Culebra, Ñandurire				X	-	-	-	W
Dryophylax chaquensis	Ojo de gato, Mboi capi'i	X	1	1	X	LC	-	-	W
Erythrolamprus aesculapii	Falsa coral, Mboi chumbe				X	LC	-	-	W
Erythrolamprus almadensis	Falsa yarará	X			X	LC	-	-	W
Erythrolamprus jaegeri	Culebra, Mboi hovy				X	LC	-	-	W
Erythrolamprus poecilogyrus	Culebra, Mboi capitán		2	2	X	LC	-	-	W
Erythrolamprus semiaureus	Culebra de agua, Mboi				X	LC	-	-	W
Helicops leopardinus	Culebra de agua, Mboi				X	LC	-	-	W
Hydrodynastes gigas	Ñacaniná		1	1	X	LC	-	-	W
Lygophis dilepis	Culebra, Mboi capi'i				X	LC	-	-	W
Mussurana bicolor	Musurana, Ñakanina hũ				X	LC	-	-	W
Oxyrhopus guibei	Falsa coral, Mboi chumbe				X	LC	-	-	W
Phalotris matogrossensis	Culebra, Mboi tata				X	LC	-	-	W
Philodryas olfersii	Culebra, Mboi hovy				X	LC	-	-	W
Pseudablabes patagoniensis	Parejera, Ñuaso				X	LC	-	-	-
Xenodon merremii	Sapera, Mboi pe say'ju				X	-	-	-	W
Elapidae									

Table 5.3.2.3.2.c
List of species recorded during herpetofauna survey campaigns and secondary data (AII)

Order/Family/*Species*	Popular name	Campaign		Total	AII	Status of Conservation			End.
		1C	2C			IUCN (2022)	CITES (2023)	MADES (2019, 2020)	
Micrurus frontalis	Coral, Mboi chumbe				X	LC	-	-	W
Typhlopidae									
Amerotyphlops brongersmianus	Culebra, Yvytaso				X	LC	-	-	W
Viperidae									
Bothrops alternatus	Crucera, Jarara				X	LC	-	-	W
Bothrops diporus	Yarara, Kyryry'o				X	LC	-	-	W
Total			**30**	**30**					

Legend: Conservation Status: DD - "Insuficient data", LC - "Low Concern"; Appendix II (CITES, 2023) - species that are not necessarily threatened with extinction, but whose trade must be controlled to avoid uses incompatible with their survival. Endemism: EC – Open Areas, W – Large Distribution.

Lists of Bats Species

Table 5.3.2.4.3.a
List of species recorded during the first bat survey campaign

Order/Family/*Species*	Popular name	Records	Status of Conservation		
			MADES 2017	IUCN 2022	CITES 2023
Chiroptera					
Molossidae					
Eumops perotis	murciélago	28	-	LC	-
Eumops sp.	murciélago	50	-		
Molossops temminckii	murciélago	27	-	LC	-
Molossus molossus	murciélago	6	-	LC	-
Molossus rufus	murciélago	7	-	LC	-
Nyctinomops laticaudatus	murciélago	35	-	LC	-
Promops centralis	murciélago	8	-	LC	-
Vespertilionidae					
Eptesicus furinalis	murciélago	90	-	LC	-
Lasiurus blossevillii	murciélago	36	-	LC	-
Lasiurus ega	murciélago	168	-	LC	-
Myotis albescens	murciélago	24	-	LC	-
Myotis nigricans	murciélago	8	-	LC	-
Myotis riparius	murciélago	1	-	LC	-
Total		**488**			

Legend: Status of conservation: LC - "Low Concern".

Table 5.3.2.4.3.b
List of species recorded during the second bat survey campaign

Order/Family/*Species*	Popular name	Records	Status of Conservation		
			MADES 2017	IUCN 2022	CITES 2023
Chiroptera					
Molossidae					
Eumops perotis	murciélago	5	-	LC	-
Eumops sp.	murciélago	12	-		
Nyctinomops laticaudatus	murciélago	13	-	LC	-
Promops centralis	murciélago	2	-	LC	-
Noctilionidae					
Noctilio leporinus	murciélago pescador	2	-	LC	-
Vespertilionidae					
Eptesicus furinalis	murciélago	16	-	LC	-
Lasiurus blossevillii	murciélago	34	-	LC	-
Lasiurus ega	murciélago	18	-	LC	-
Myotis nigricans	murciélago	1	-	LC	-
Total		**103**			

Legend: Status of conservation: LC - "Low Concern".

JGP

atome

Table 5.3.2.4.3.c
List of species recorded during bat survey campaigns and secondary data (AII)

Order/Family/Species	Popular name	Campaign		AII	Total	Status of Conservation		
		1ªC	2ªC			MADES 2019	IUCN 2022	CITES 2023
Chiroptera								
Emballonuridae								
Peropteryx macrotis	bat			x		Sí	LC	-
Molossidae								
Cynomops abrasus	bat			x		-	DD	-
Cynomops planirostris	bat			x		-	LC	-
Eumops auripendulus	bat			x		-	LC	-
Eumops bonariensis	bat			x		-	LC	-
Eumops dabbenei	bat			x		-	LC	-
Eumops glaucinus	bat			x		-	LC	-
Eumops perotis	bat	28	5	x	33	-	LC	-
Eumops sp.	bat	50	12		62	-		-
Molossops temminckii	bat	27		x	27	-	LC	-
Molossus molossus	bat	6		x	6	-	LC	-
Molossus rufus	bat	7		x	7	-	LC	-
Nyctinomops laticaudatus	bat	35	13	x	48	-	LC	-
Promops centralis	bat	8	2	x	10	-	LC	-
Promops nasutus	bat			x		-	LC	-
Tadarida brasiliensis	bat			x		-	LC	-
Noctilionidae								
Noctilio albiventris	Sinful bat			x		-	LC	-
Noctilio leporinus	Sinful bat		2	x	2	-	LC	-
Vespertilionidae								
Eptesicus diminutus	bat			x			LC	
Eptesicus furinalis	bat	90	16	x	106	-	LC	-
Lasiurus blossevillii	bat	36	34	x	70	-	LC	-
Lasiurus ega	bat	168	18	x	186	-	LC	-

Table 5.3.2.4.3.c
List of species recorded during bat survey campaigns and secondary data (All)

Order/Family/Species	Popular name	Campaign		All	Total	Status of Conservation		
		1ªC	2ªC			MADES 2019	IUCN 2022	CITES 2023
Lasiurus villosissimus	bat			x		-	LC	-
Myotis albescens	bat	24		x	24	-	LC	-
Myotis levis	bat			x		-	LC	-
Myotis nigricans	bat	8	1	x	9	-	LC	-
Myotis riparius	bat	1		x	1	-	LC	-
Myotis ruber	bat			x		-	NT	-
Myotis simus	bat			x		-	DD	-
Total		**488**	**103**		**591**			

Legend: Conservation Status: LC - "Low Concern", NT - "Near Threatened", DD – Insuficient data.

Lists of Large and Medium Mammal Species

Table 5.3.2.4.a
List of species recorded during the first survey campaign of Medium and Large Mammals

Order/Family/*Species*	Popular name	Records	Status of Conservation		
			MADES 2017	IUCN 2022	CITES 2023
Didelphimorphia					
Didelphidae					
Didelphis albiventris	comadreja común	1	-	LC	-
Cingulata					
Dasypodidae					
Dasypus novemcinctus	mulita grande	1	-	LC	-
Pilosa					
Myrmecophagidae					
Tamandua tetradactyla	oso melero	1	-	LC	-
Primates					
Atelidae					
Alouatta caraya	mono aullador	5	-	LC	II
Lagomorpha					
Leporidae					
*Sylvilagus brasiliensis**	conejito de monte	1	-	LC	-
Carnivora					
Canidae					
Cerdocyon thous	zorro cangrejera	7	-	LC	II
Procyonidae					
Procyon cancrivorus	mapache comedor de cangrejos	2	-	LC	-
Felidae					
Felidae NI	felino silvestre	1	-	-	II
Herpailurus yagouaroundi	gato moro	1	-	LC	II
Leopardus geoffroyi	gato montés	1	-	LC	II

Table 5.3.2.4.a
List of species recorded during the first survey campaign of Medium and Large Mammals

Order/Family/*Species*	Popular name	Records	Status of Conservation		
			MADES 2017	IUCN 2022	CITES 2023
Cetartiodactyla					
Cervidae					
Subulo gouazoubira	corzuela	2	-	LC	-
Total		**23**			

Legend: * Concept of species lato sensu. Conservation Status: LC - "Low Concern"; Appendix II - species that are not necessarily threatened with extinction, but whose trade must be controlled to avoid uses incompatible with their survival.

Table 5.3.2.4.b
List of species recorded during the first survey campaign of Medium and Large Mammals

Order/Family/*Species*	Popular name	Records	Status of Conservation		
			MADES 2017	IUCN 2022	CITES 2023
Didelphimorphia					
Didelphidae					
Didelphis albiventris	comadreja común	11	-	LC	-
Philander quica	comadreja de cuatro ojos	8	-	-	-
Cingulata					
Dasypodidae					
Dasypus novemcinctus	mulita grande	7	-	LC	-
Primates					
Atelidae					
Alouatta caraya	mono aullador	1	-	LC	II
Lagomorpha					
Leporidae					
*Sylvilagus brasiliensis**	conejito de monte	2	-	LC	-
Carnivora					
Canidae					
Cerdocyon thous	zorro cangrejera	17	-	LC	II
Procyonidae					
Procyon cancrivorus	mapache comedor de cangrejos	8	-	LC	-
Felidae					
Felidae NI	felino silvestre	2	-	-	II
Cetartiodactyla					
Cervidae					
Subulo gouazoubira	corzuela	6	-	LC	-
Total		**62**			

Legend: * Concept of species lato sensu. Conservation Status: LC - "Low Concern"; Appendix II - species that are not necessarily threatened with extinction, but whose trade must be controlled to avoid uses incompatible with their survival.

JGP

atome

Table 5.3.2.4.c
List of species recorded during mammalian survey campaigns and from secondary data (AII)

Order/Family/*Species*	Popular name	Campaign		AII	Total	Status of conservation		
		1ªC	2ªC			MADES 2019	IUCN 2022	CITES 2023
Didelphimorphia								
Didelphidae								
Didelphis albiventris	comadreja común	1	11	X	12	-	LC	-
Philander quica	comadreja de cuatro ojos		8		8	-	-	-
Dasypodidae								
Dasypus novemcinctus	mulita grande	1	7	X	8	-	LC	-
Cabassous chacoensis	cabasú chico			X		-	NT	-
Chaetophractus vellerosus	tatú llorón			X		-	LC	-
Chaetophractus villosus	tatú peludo			X		-	LC	-
Cingulata								
Dasypus hybridus	mulita pampeana			X		-	NT	-
Chlamyphoridae								
Euphractus sexcinctus	tatú peludo			X		-	LC	-
Priodontes maximus	armadillo gigante			X		Sí	VU	I
Tolypeutes matacus	tatú bolita			X		-	NT	-
Pilosa								
Myrmecophagidae								
Myrmecophaga tridactyla	oso hormiguero			X		Sí	VU	II
Tamandua tetradactyla	oso melero	1		X	1	-	LC	-
Primates								
Atelidae								
Alouatta caraya	mono aullador	5	1	X	6	-	LC	II
Cebidae								
Aotus azarae	mono de noche			X		-	LC	II
Mico melanurus	mono			X		-	LC	II
Sapajus cay	mono ka´i - ka´i			X		-	LC	II

Table 5.3.2.4.c
List of species recorded during mammalian survey campaigns and from secondary data (AII)

Order/Family/*Species*	Popular name	Campaign		AII	Total	Status of conservation		
		1ªC	2ªC			MADES 2019	IUCN 2022	CITES 2023
Pitheciidae								
Callicebus pallescens	mono titi			X		-	LC	II
Lagomorpha								
Leporidae								
*Sylvilagus brasiliensis**	conejito de monte	1	2	X	3	-	LC	-
Rodentia								
Caviidae								
Cavia aperea	cuis			X		-	LC	-
Hydrochoerus hydrochaeris	carpincho			X		-	LC	-
Myocastoridae								
Myocastor coipus	falsa nutria			X		-	LC	-
Cuniculidae								
Cuniculus paca	paca			X		-	LC	-
Carnivora								
Canidae								
Cerdocyon thous	zorro cangrejera	7	17	X	24	-	LC	II
Chrysocyon brachyurus	lobo de crin			X		Sí	LC	II
Lycalopex gymnocercus	zorro de campo			X		-	LC	II
Mephitidae								
Conepatus chinga	zorrino			X		-	LC	-
Mustelidae								
Eira barbara	hurón mayor			X		-	LC	-
Galictis cuja	grisón menor			X		-	LC	-
Lontra longicaudis	lobito de rio			X		-	NT	I
Pteronura brasiliensis	nutria gigante			X		Sí	EN	I
Procyonidae								
Nasua nasua	coati			X		-	LC	-

Table 5.3.2.4.c
List of species recorded during mammalian survey campaigns and from secondary data (AII)

Order/Family/*Species*	Popular name	Campaign		AII	Total	Status of conservation		
		1ªC	2ªC			MADES 2019	IUCN 2022	CITES 2023
Procyon cancrivorus	mapache comedor de cangrejos	2	8	X	10	-	LC	-
Felidae								
Herpailurus yagouaroundi	gato moro	1		X	1	-	LC	II
Leopardus braccatus	gato de los pajonales			X		-	NT	II
Leopardus geoffroyi	gato montés	1		X	1	-	LC	I
Leopardus pardalis	ocelote			X		-	LC	I
Leopardus tigrinus	jaguarete'i			X		Sí	VU	I
Leopardus wiedii	tigrillo de cola larga			X		-	NT	I
Puma concolor	léon			X		-	LC	II
Panthera onca	tigre			X		Sí	NT	I
Felidae NI	felino silvestre	1	2		3	-	-	II
Perissodactyla								
Tapiriidae								
Tapirus terrestris	tapir			X		Sí	VU	II
Cetartiodactyla								
Cervidae								
Blastocerus dichotomus	ciervo de los pantanos			X		Sí	VU	I
Mazama americana	venado rojo			X		-	DD	-
Subulo gouazoubira	corzuela	2	6	X	8	-	LC	-
Tayassuidae								
Catagonus wagneri	peccarí chaqueño			X		Sí	EN	II
Dicotyles tajacu	pecarí de collar			X		-	LC	II
Tayassu pecari	pecarí de labio blanco			X		Sí	VU	II
Total		**23**	**62**	**0**	**85**			

Legend: * Species concept lato sensu. Conservation Status: EN - "Endangered", VU - "Vulnerable", LC - "Low Concern", NT - "Neart Threatened", DD – Insufficient data; Appendix I - endangered species, trade in which will only be authorized in exceptional circumstances, Appendix II - species that are not necessarily endangered, but whose trade must be controlled to avoid uses incompatible with their survival.

Annex 11 – Expanded Stakeholder Map

Stakeholders Matrix

Table 1. Stakeholders Matrix

Institution/Organization	Mandate	Interests	Level of Incidence
ATOME	Executor of the project	Installation of an industrial plant in the city of Villeta.	High
Mayor of the Municipality of Villeta	City Manager, highest authority of the Municipality.	To achieve political legitimacy, to position Villeta as an industrial city, to increase revenues in the form of fees and taxes for the city.	High
Municipality Council	Legislative branch within the Municipality, in charge of enacting and enforcing municipal laws and ordinances	Ensure compliance with municipal regulations. Limit the establishment of new industries.	High
Ministry of Environment and Sustainable Development (MADES)	Institution responsible for granting environmental licenses for the execution of projects at the country level. Authority for the application of environmental regulations.	Ensure compliance with environmental regulations.	High
Ministry of Industry and Trade (MIC)	Develop strategies for the implementation of the country's industrial policy instruments, through actions that favor	Ensure compliance with legislation that regulates and favours investment and industrial development.	Medium

Institution/Organization	Mandate	Interests	Level of Incidence
	national and foreign investments and increase competitiveness in the face of globalization and trade liberalization.		
Ministry of Labour, Employment and Social Security (MTESS)	To govern the policy and exercise the administrative regulation of the Labor, Employment, and Social Security regime; supervising compliance with current labor regulations.	Foster decent work and promote productive employment through efficient and effective management that ensures compliance with labour rights.	Low
Ministry of Public Works and Communications (MOPC) Directorate of Roads	Responsible for public works at the national level.	Maintain the public road infrastructure in the area of influence (Villeta – Alberdi Route) in adequate service conditions. Approve a road impact mitigation project to be developed by ATOME.	Medium
National Secretariat of Culture (SNC)	Design and execute the cultural policies of the State, the governing body that designs, regulates and promotes cultural policies, committed to the protection of the country's	Protect cultural heritage, promote its dissemination and conserve, recover and restore the assets that make it up.	Low

Institution/Organization	Mandate	Interests	Level of Incidence
	cultural heritage and its diversity.		
San Rafael Farm	Property settled in the AID of the project.	Be a beneficiary of mitigation measures and compensation for the potential impacts of the project.	Medium
Workers of the San Rafael Farm	People who live and carry out economic activities in the area of influence.	Recipients of mitigation measures due to the potential impacts of the project.	Medium
Owner of Agricultural Land (Rice)	Property settled in the AID of the project.	Be a beneficiary of mitigation measures and compensation for the potential impacts of the project.	Medium
Lola Farm	Property settled in the AID of the project.	Recipients of mitigation measures due to the potential impacts of the project.	Medium
Substation Buey Rodeo (ANDE)	Provision of electricity in the area.	Provide an efficient electricity supply service in the area.	High
Police Station 49 Surubí-y km 19 Villeta	Institution responsible for citizen security in the project's area of influence. Intervention in criminal acts in the area.	Maintain public order and security in the area of its jurisdiction.	Low

Institution/Organization	Mandate	Interests	Level of Incidence
City of Villeta Firefighters	Institution in charge of prevention, extinguishment, assistance and education in the event of accidents and accidents.	Accident prevention through the verification of the installations of fire protection systems in the city's industries and companies.	Medium
Villeta Neighborhood Commission and Organizations	Community organizations in the territory with a social mobilization force.	Job opportunities for community members.	Low
Small economic units settled in the area	Residents of the area.	Opportunity for economic income from the sale of your products.	Low
Naval Prefecture of Villeta	Protection and control of activities carried out on the Paraguay River.	Maintain order, safety and ensure navigability.	Low
Corporate groups based in the area	Economic sector with an impact on the market.	Rent-seeking, market expansion, taking advantage of the Paraguay-Paraná waterway, limiting regulations. Find business partners.	Low
Private Ports	Facilitate international trade and improve the competitiveness of businesses by providing a favourable logistics environment.	Acquisition of business partners and customers.	Medium

Institution/Organization	Mandate	Interests	Level of Incidence
FAO (Environmentalist)	International NGO, advocacy on public opinion.	Work on various aspects related to the environment, carry out actions that avoid and minimize adverse environmental impacts.	Low

Annex 12 – Carbon Footprint Calculation

Carbon footprint associated with the ATOME value chain

December 2023

ATOME PARAGUAY S.A.E Avda. Aviadores del Chacho 2050 Edificio WTC Torre 3 Piso 15
Asunción, Paraguay

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Carbon footprint associated with the ATOME value chain

Carbon Footprint Calculation Framework

The carbon footprint calculation methodology involves assessing the environmental impact of an entity, an organization, a product, or even an individual, in terms of the amount of greenhouse gases (GHG) released into the atmosphere during its life cycle, which can be caused both directly and indirectly by daily activities. [1]

The main objective of the carbon footprint calculation is to provide an analysis to understand and quantify GHG emissions and their contribution to climate change. This information is crucial for making informed decisions and developing emission reduction strategies. In addition, the carbon footprint is also used to promote transparency and environmental accountability, as it allows organizations and consumers to assess their climate impact and take action to mitigate it.

ATOME Value Chain Emissions

ATOME's core business is the production of hydrogen, ammonia and green fertilizers. It is estimated that 100,000 tons of green ammonia will be produced, using 20,000 tons of hydrogen produced at the plant through the process of alkaline electrolysis of water with renewable energy sources, resulting in a production process of zero CO_2 emissions. This ammonia production will be used in the plant for the production of calcium ammonium nitrate (CAN), a widely consumed nitrogen-based fertilizer. The annual production of CAN is estimated at 250,000 tons.

As for ATOME's direct emissions, they are mainly related to the green ammonia production process, composed mainly of non-polluting gases such as H_2, N_2, H_2O, O_2 and Ar. Pollutant gases such as traces of NO_x, CO_2, CO and NH_3 would be emitted in specific events or emergency situations through flare systems. In addition, liquid droplets are expected in gaseous streams of KOH solution during ventilation. During fertilizer production, the main source of emissions is the production of nitric acid, where emissions of nitrogen oxide (NO_x) gases, specifically unreacted N_2O, resulting as a byproduct of the catalytic oxidation of ammonia (NH_3) at high temperatures are expected to occur. In addition, a certain amount of NO_x (NO, NO_2 and N_2O) is produced, mainly during the start-up and shutdown of the reaction, when the process is less stable. The nitric acid plant is designed to minimise N_2O emissions with a tail gas outlet reduction system.

Finally, it is important to consider the logistics of transporting employees, as well as the distribution and marketing of the CAN. The flue gases would be emitted by land transport vehicles, barges and container ships used for river and sea transport.

Definition of scope and limits

To start accounting for GHG emissions, 2022 was selected as the start of construction and site preparation for plant installation, and 2025 was chosen as the baseline for the start of ATOME production. The accounting of GHGs in relation to the operational limit was carried out following the scope of the Greenhouse Gas Protocol, being: [2]

1. Scope 1: Direct emissions from ATOME's own or controlled activities, including those derived from the production of ammonia and CAN, vehicles used for personnel transport and effluent treatment.
2. Scope 2: indirect emissions associated with purchased electricity.
3. Scope 3: Indirect emissions from activities that occur from sources outside of ATOME's control and not classified as Scope 2. These include emissions from the operation phase of the plant, those inherent to the production of raw materials used in the operation, the movement of equipment, machinery and operating personnel, the transport and

distribution of raw materials and finished products, and the use and final disposal of final products.

Due to the fact that GHG emissions during the construction phase are not continuous throughout the useful life of the plant, such as those inherent to the production of the raw materials used (iron, cement, plastics, etc.), the movement of equipment, machinery and personnel, among others, an additional section is presented in the results with the total amount of GHG emissions in the passage of time of the constructions.

Methodology

The basic methodology used to estimate greenhouse gas emissions *(E)* is the generic equation that multiplies the Activity Data *(DA)* by its corresponding Emission Factor (*FAITH*) as shown in the equation (1). The *GIVES* are defined as the magnitude of a human activity that results in GHG emissions or removals (e.g., transportation fuel consumption), occurring over a given period of time and in a specific area. Emission factors facilitate the calculation of GHG emissions, expressed in their respective international units, and converted to metric tons of carbon dioxide equivalent (t CO2-eq)[i]. These are coefficients that are used to quantify the emissions or removals of a GHG, considering the unit of measurement of the *GIVES*. These factors are based on measurement samples, averaged with different levels of detail according to the level of methodology used, with the aim of developing a representative emission rate for a specific level of activity under a set of specific operating conditions. Numerous reference sources were consulted to select the most appropriate conversion factors, and the 2006 and 2019 IPCC Guidelines were applied, taking into account selection criteria such as accessibility, consistency, and transparency in revisions and updates. [1] [3]

$$\boldsymbol{E} = \boldsymbol{EF} \times \boldsymbol{AD} \qquad (1)$$

Calculation of GHG emissions associated with the value chain

Most of the emission factors were used directly as defined in the chosen references. In some cases, it was necessary to calculate specific appropriate factors, e.g. using average values when there were small differences between sources (i.e. type of transport, such as light vehicles, trucks, barges). In addition, in some cases, proprietary data and results of studies carried out by URBAS, ATOMA's contractor for the FEED study, were used[ii].

[i] CO2-eq is the universal unit of measurement that indicates the global warming potential (GWP) of greenhouse gases, expressed in terms of the GWP of one unit of carbon dioxide.

[ii] Front-end design engineering

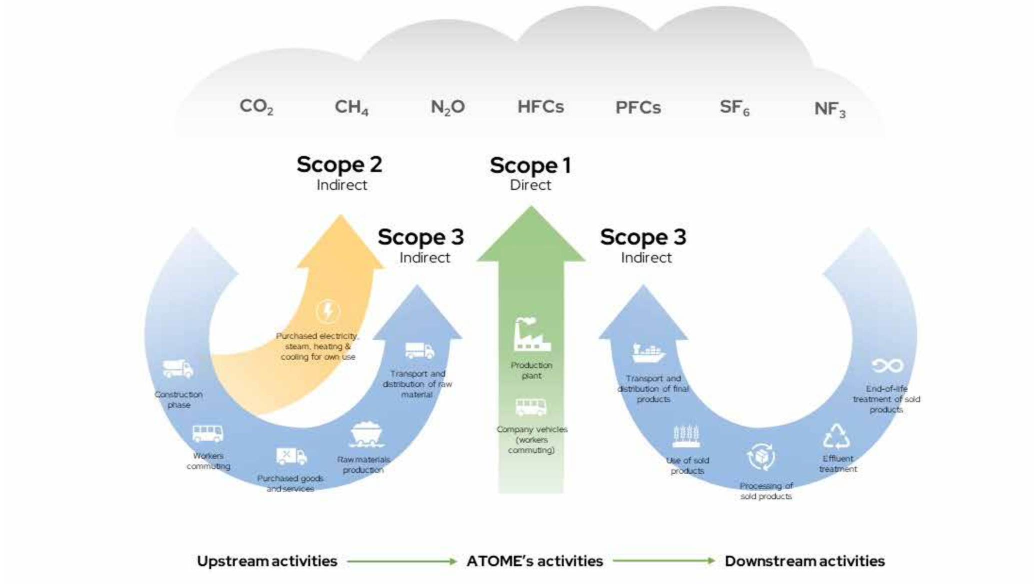

Figure 1. Carbon Footprint Scope Framework

Carbon footprint results

Ammonia Production Scenario

For the ammonia production scenario, the potential direct and indirect GHG emissions from the ATOME project are considered. Scope 1 covers emissions from the production process and employee displacement. Scope 2 covers indirect emissions from the procurement of energy services. Finally, Scope 3 considers indirect emissions from upstream activities, including emissions during the construction phase related to land use change and the production of raw materials to be used in the production process of the ATOME plant. Downstream activities include effluent treatment, transportation and distribution of green ammonia from the ATOME plant to industrial facilities in Paraguay, specifically in the Villeta Industrial Zone, capable of converting ammonia into ammonia-based fertilizers such as CAN. For comparison purposes, a grey ammonia carbon footprint scenario is included[iii], along with their potential direct and indirect emissions from production, energy consumption and downstream activities, such as transport and distribution from Europe to Paraguay for conversion into ammonia-based fertilisers – see Board 1. These two frameworks for studying the carbon footprint of ammonia will be used to compare and assess the GHG emissions avoided as a result of the implementation of the ATOME project. The methodologies, calculations, and benchmarks used to Board 1 are compiled in the section "Methodologies and calculations used for the carbon footprintMethodologies and calculations used for the carbon footprint"

Board 1. Carbon footprint scenario of ammonia production

Source of Emission			GHG emissions, t CO2-eq/ t NH3	
			ATOME (Green Ammonia)	World (Grey Ammonia)
Reach 1	1.1. Emissions from the production phase of NH3	1.1.1. Production Process	0.020	2.95
		1.1.2. Worker commuting	6.72E-04	-
		Subtotal	0.021	2.95
Scope 2	2.1. Fossil fuel combustion activities (electricity generation)		-	0.32

[iii] Produced from fossil fuels.

	2.2. Fugitive emissions from fuel production			-	1.33E-05
	2.3. Renewable energy (hydropower)			0.25	-
			Subtotal	0.25	0.32
Scope 3	1.1. Upstream activities	1.1.1. Emissions from the construction phase	Land Use Change	0.043	-
		1.1.2. Production of raw materials and inputs		0.0045	0.0045
		1.1.3. Transport of raw materials and inputs		1.39E-04	-
	1.2. Downstream activities	1.2.1. Ground Transportation and Distribution (a) ATOME Plant in the Villeta Industrial Zone (b) Port of Villeta to Villeta Industrial Zone		0.0032 (a)	0.0016 (b)
		1.2.2. River/sea transport and distribution c) European market to the port of Villeta		-	0.056 (c)
		1.2.3. Effluent treatment		-	-
			Subtotal	0.051	0.062
			Total, t CO2-eq/t NH3	0.32	3.33
			Total, t CO2-eq/t N	0.39	4.04
			Total, t CO2-eq/year	32,000	333,000

In addition, GHG emissions during the 22 months of construction of the green ammonia plant were considered and separated from the carbon footprint scenario of ammonia production in Table 1 because they are not continuous emissions during the years of operation of the plant. Emissions related to the production of construction materials, emissions from the use of machinery and vehicles, and other construction activities are accounted for and summarized in the Board 2. The methodologies, calculations, and benchmarks used to Board 2 are compiled in the section "Methodologies and calculations used for the carbon footprint."

Board 2. Total Emissions During the Construction Phase of the Ammonia Plant

Source of Emission	GHG emissions, t CO2-eq
Materials, assembly and construction activities	3,165.27
Transmission Line	400
Emissions from vehicles and equipment used during construction	554.3[iv]
Workers' travel for the construction phase	42.74
Total, t CO2-eq	4,164.31

CAN Production Scenario

For the CAN production scenario, the potential direct and indirect GHG emissions of the ATOME project are considered. Scope 1 covers direct emissions from the production process and the posting of employees. Scope 2 considers indirect emissions related to the procurement of energy services. Finally, Scope 3 addresses initial indirect emissions or upstreams, including the acquisition and transportation of feedstock (dolomite) from the extraction quarries in Concepción to the ATOME plant. Downstream activities include GHG emissions and removals due to the use of fertilizer in Latin America's two largest crops, soybeans and sugarcane, as well as the transportation and distribution of green CAN from the ATOME plant to national and international

[iv] A range of emissions related to vehicles used in construction was assumed. The upper limit is used for a more conservative scenario.

markets, effluent treatment and final disposal of products. For comparison purposes, a scenario of the carbon footprint of CAN produced from fossil fuels is included, along with its potential direct and indirect emissions from production, energy consumption and downstream activities, such as transport and distribution from Europe to the markets of Paraguay and Brazil – see Board 3. These two frameworks for studying CAN's carbon footprint will be used to compare them and appreciate the greenhouse gas emissions avoided by the implementation of the ATOME project. The methodologies, calculations, and benchmarks used to Board 3 are compiled in the section "Methodologies and calculations used for the carbon footprint"

Board 3. Carbon footprint of the CAN production scenario

Source of Emission				GHG emissions, t CO2-eq/ t CAN	
				ATOME (Green CAN)	World (CAN Grey)
Scope 1	1.2. Emissions due to CAN production	1.2.1. Ammonia production		0.0083	1.18
		1.2.2. NA Production		0.023	1.80
		1.2.3. ANS, granulation and CAN production		-	-
		1.2.4. Worker commuting		5.4E-04	-
			Subtotal	0.032	2.98
Scope 2	2.4. Fossil fuel combustion activities (electricity generation)			-	0.13
	2.5. Fugitive emissions from fuel production			-	5.32E-06
	2.6. Renewable energy (hydro)			0.097	-
			Subtotal	0.097	0.13
Scope 3	3.1. Upstream activities	3.1.1. Emissions from the construction phase	Land Use Change	0.017	-
		3.1.2. Production of raw materials and inputs		0.44	-
		3.1.3. Transportation of raw materials and supplies (excluding Dolomite)		9.37E-04	-
		3.1.4. Transport from Dolomite to ATOME plant		3.09E-03	-
	3.2. Downstream activities	3.2.1. CO2 and N2O emissions from managed soils. Application of the CAN in agriculture		1.66	1.66
		3.2.2. CO2 removal through agricultural activity (sugarcane)		-1.48	-1.48
		3.2.3. Road transport and distribution (a) ATOME plant to the Paraguayan market (b) ATOME plant in the Brazilian market		0.0026 (a) 0.16 (b)[v]	-
		3.2.4. River/sea transport and distribution: (c) ATOME plant in the Brazilian market (d) European market to the Paraguayan market		0.018 (c)	0.074 (d)
		3.2.5. Effluent treatment		0.011	-
		3.2.6. End-of-life treatment of CAN		1.38E-04	1.38E-04
			Subtotal	0.83	0.25
			Total, t CO2-eq/t CAN	0.96	3.36
			Total, t CO2-eq/t N	3.55	12.44
			Total, t CO2-eq/year	240,000	840,000

[v] This value is used for the subtotal of Scope 3 emissions, as it represents the highest value for the "Transport and distribution of CAN by road" section.

In the same way as in the ammonia production scenario, GHG emissions during the 22 months of construction of the CAN plant were considered and separated from the CAN carbon footprint scenario (Table 3) because they are not continuous emissions during the years of operation of the plant. Emissions related to the production of construction materials, emissions from the use of machinery and vehicles, and other construction activities are accounted for and summarized in the Board 4. The methodologies, calculations and benchmarks used for the Board 4 are collected in the section "Methodologies and calculations used for the carbon footprint".

Board 4. Total Emissions During the Construction Phase of the CAN Plant

Source of Emission	GHG emissions, t CO2-eq
Materials, assembly and construction activities	11,728.2
Transmission Line	400
Emissions from vehicles and equipment used during construction	554.3[vi]
Workers' travel for the construction phase	42.74
Total, t CO2-eq	12,725.24

[vi] A range of emissions related to vehicles used in construction was assumed. The upper limit is used for a more conservative scenario.

Methodologies and calculations used for the carbon footprint

Scope 1

Direct emissions from activities owned or controlled by ATOME. These are direct emissions that occur during the production process using elements that are owned and controlled by the company, including emissions from boilers, furnaces, machinery and equipment, and fuel-using vehicles.

Source of Emission	Description	Methodology	Emissions	Reference
Grey ammonia production	The production of ammonia requires one source of nitrogen (N2) and one source of hydrogen (H2). Nitrogen is obtained from the air through cryogenic distillation, while hydrogen is primarily derived from natural gas (mainly methane, CH4). Since the industry is predominantly dependent on natural gas, the methodology and emission sources are based on the production of ammonia from natural gas. Emissions are estimated from total fuel requirements or values derived from estimates of total fuel requirements used in NH3 production. Energy requirements from fuels are not accounted for separately, so the value obtained from emissions from the energy sector must be corrected by eliminating it. The parameters and assumptions used for the calculation are as follows: [1] • AP = 100,000 t NH3/year • FR = 42.5 GJ/t of NH3 produced[VII] • CCF = 21.0 kg C/GJ • FOC = 1 • R_{CO2}= 0 t CO2 recovered for later use in a secondary process	<u>CO2 emissions from ammonia production:</u> $E_{CO2} = AP \cdot FR \cdot CCF \cdot FOC \cdot 44/12 - R_{CO2}$ Where: E_{CO2} = CO2 emissions, kg/year AP = Ammonia production, t NH3/year FR = Fuel requirement per unit of production, GJ/ton of ammonia produced CCF = Fuel Carbon Content Factor, kg C/GJ FOC = Fuel Carbon Oxidation Factor, Fraction R_{CO2} = CO2 recovered for further use in a secondary process (e.g. urea production), kg	E_{CO2} = 327,300 t CO2/year This value is corrected by eliminating the emissions generated by electricity consumption (Scope 2 – purchased electricity) E_{CO2} (corrected) = 295,455.4 t CO2/year	2006 IPCC guidelines for national greenhouse gas inventories. Volume 3: Industrial Processes and Product Use
Green ammonia production	The production of green ammonia is based on the replacement of the hydrogen source used in the process with hydrogen produced by electrolysis of water using renewable energy sources. In the case of the ATOME project, the hydrogen will be produced by electrolysis of treated and demineralized water from the Paraguay River with zero CO2 emissions. Certain sources of inert gas emissions such as O2, H2O (steam), N2, originate from various sources within the production process, in addition to occasional CO2 and NOx emissions from the operation of diesel emergency generators and auxiliary flares. The	The data and results obtained from the specific studies of the 120 MW Villeta project provided by the company in charge of the Engineering Design (URBAS) were used. <u>Ammonia Secondary Torch:</u> 29,626 kg/h*500 h/year = 14,813 t/year (composed mostly of N2) • 0.076 % (w/w) CO2 = 11.2 t CO2/year • 0.042 % (w/w) CO = 6.2 t CO2/year • 7.7e-03 % (w/w) NOx = 1.14 t NOx/year	<u>Total Annual Emissions:</u> • CO2 = 575.95 t CO2/year • CO = 124.05 t CO/year • NOx = 5.04 t NOx/year <u>Total annual CO2-eq emissions:</u> • CO2-eq = 575.95 t CO2/year*(1) + 5.04 t NOx/year*(296) = 2,067.8 t CO2-eq/year	FEED of the project carried out by URBAS/Casale

VII Information on fuel type, carbon content factor, and carbon oxidation factor is not available. Therefore, it is considered good practice to use the average value for partial oxidation as presented in Table 3.1, Volume 3: Industrial Processes and Product Use [1]

<table>
<tr><th>Source of Emission</th><th>Description</th><th>Methodology</th><th>Emissions</th><th>Reference</th></tr>
<tr><td></td><td>following table presents a summary of emissions from stationary sources within the ATOME project.
<table>
<tr><td></td><td>Quemador + pilotos C3H8</td><td>Quemador + pilotos C3H8</td><td>Dos pilotos (Standby)</td><td>Dos pilotos (Standby)</td></tr>
<tr><td>Componente</td><td>Caudal más. kg/h</td><td>Caudal vol. Nm³/h</td><td>Caudal más. kg/h</td><td>Caudal vol. Nm³/h</td></tr>
<tr><td>CO2</td><td>22.38</td><td>11.40</td><td>22.38</td><td>11.40</td></tr>
<tr><td>H2O</td><td>6,664.22</td><td>8,288.75</td><td>12.22</td><td>15.19</td></tr>
<tr><td>N2</td><td>22,920.34</td><td>18,340.14</td><td>89.34</td><td>71.49</td></tr>
<tr><td>NOx</td><td>2.28</td><td>1.70</td><td>0.010</td><td>0.008</td></tr>
<tr><td>CO</td><td>12.42</td><td>9.93</td><td>0.055</td><td>0.044</td></tr>
<tr><td>Inquemados</td><td>4.70</td><td>6.17</td><td>0.021</td><td>0.011</td></tr>
<tr><td>TOTAL</td><td>29,626.34 kg/h</td><td>26,658.09 Nm³/h</td><td>124.026 kg/h</td><td>98.143 Nm³/h</td></tr>
</table>
<table>
<tr><th>Descripción</th><th>Coordenadas</th><th>ncionamien</th><th>Altura</th><th>Vs</th><th>Caudal salida</th><th></th><th>Temp. Salida</th><th>Presión salida</th><th>Diametro chimenea</th><th>Composición (%Vol)</th></tr>
<tr><td>Aux boiler exhaust stack</td><td>429539, 7156453</td><td>EVENTUAL <500h/año</td><td>25</td><td>22.6</td><td>841</td><td>1078</td><td>550</td><td>ambiente</td><td>200</td><td>71% N2, 9.5% H2O, 9% CO2, 8.5% CO, 2% Ar <2500 mg/Nm3 NOx, <25 mg/Nm3 PM, <450 mg/Nm3 CO, <125 mg/Nm3 HC, SO2 dependerá de contenido S en diésel</td></tr>
</table>
<table>
<tr><th>Itens</th><th>Coordenadas</th><th></th><th>Condición</th><th>altura</th><th>Velo.</th><th>Caudal salida</th><th></th><th>Temp. Salida</th><th>Presión salida</th><th>Diámetro Chimenea</th><th>Composición (%Vol)</th></tr>
<tr><th></th><th>X</th><th>Y</th><th></th><th>(m)</th><th>(m/s)</th><th>(Nm3/h)</th><th>(kg/h)</th><th>(ºC)</th><th>(bar)</th><th>(mm)</th><th></th></tr>
<tr><td>Grupo Diesel emergencia</td><td>429598</td><td>7156325</td><td>Eventual <500h/año</td><td>3,5</td><td>21,8</td><td>1244</td><td>1594</td><td>574</td><td>ambiente</td><td>250</td><td rowspan="2">71% N2; 9,5%H2O; 9%CO2; 8,5%CO; 2%Ar; <2500mg/Nm3NOx; <25mg/Nm3MP; <450mg/Nm3CO; <125mg/Nm3HC; SO2 em F do S do</td></tr>
<tr><td>Grupo Diesel antincendios</td><td>4295400</td><td>7156363</td><td>Eventual promedio 0h/año</td><td>3,5</td><td>22,6</td><td>841</td><td>1078</td><td>555</td><td>ambiente</td><td>200</td></tr>
<tr><td>Venteo H2 Planta electrólisis B1</td><td>429452</td><td>7156517</td><td>Eventual <500h/año</td><td>45</td><td>17,3</td><td>20000</td><td>1800</td><td>40</td><td>30</td><td>125</td><td></td></tr>
<tr><td>Venteo O2 Planta electrólisis B1'</td><td>429565</td><td>7156398</td><td>Continuo</td><td>45</td><td>16,2</td><td>12000</td><td>16200</td><td>40</td><td>30</td><td>100</td><td>98,5%O₂; 1,5%H₂; 4g/Nm3 de H₂O y 1mg/Nm³/g KOH</td></tr>
<tr><td>Venteo H2 Planta electrólisis B2</td><td>429452</td><td>7156517</td><td>Eventual<500h/año</td><td>45</td><td>17,3</td><td>20000</td><td>1800</td><td>40</td><td>30</td><td>125</td><td></td></tr>
<tr><td>Venteo O2 Planta electrólisis B2'</td><td>429565</td><td>7156398</td><td>Continuo</td><td>45</td><td>16,2</td><td>12000</td><td>16200</td><td>40</td><td>30</td><td>100</td><td>98,5%O₂; 1,5%H₂; 4g/Nm³ de H₂O y 1mg/Nm³/g KOH</td></tr>
<tr><td>Salida aire enriquecido O₂ (B3)</td><td>429618</td><td>7156378</td><td>Continuo</td><td>7,5</td><td>19,3</td><td>10000</td><td></td><td>ambiente</td><td>5</td><td>200</td><td>Aire ambiente enriquecido en O₂ (90% O₂; 10% N₂; <5%Ar; y trazas de CO₂)</td></tr>
<tr><td>Venteo gas proceso NH3 (B4)</td><td>429667</td><td>7156421</td><td>Continuo</td><td>35</td><td>7,1</td><td>8</td><td>5</td><td>30</td><td>ambiente</td><td>20</td><td>53% H₂, 43% N₂; 2%Ar; y 0,3% de H₂O</td></tr>
</table>
</td><td><u>Ammonia Main Torch:</u>
29,626 kg/h*500 h/year = 14,813 t/year (composed mostly of N2)
• 0.076 % (w/w) CO2 = 11.2 t CO2/year
• 0.042 % (w/w) CO = 6.2 t CO2/year
• 7.7e-03 % (w/w) NOx = 1.14 t NOx/year
<u>Ammonia Main and Secondary Torch Pilot Flame:</u>
2*124 kg/h*8,260 h/year = 2,048 t/year
• 18 % (w/w) CO2 = 368.6 t CO2/year
• 0.044 % (w/w) CO = 0.9 t CO/year
• 8.06-03 % (w/w) NOx = 0.16 t NOx/year
<u>Diesel Emergency Generator:</u>
1,244 Nm3/h*500 h/year = 622,000 Nm3/year
• 9 % (v/v) CO2 = 110.05 t CO2/year
• 8.5 % (v/v) CO = 66.15 t CO/year
• <2500 mg/Nm3 NOx = 1.55 t NOx/year
<u>Auxiliary boiler exhaust chimney:</u>
1,078 kg/h*500 h/year = 539 t/year
• 9 % (v/v) CO2 = 74.9 t CO2/year
• 8.5 % (v/v) CO = 44.6 t CO/year
• <2500 mg/Nm3 NOx = 1.05 t NOx/year</td><td></td><td></td></tr>
<tr><td>Nitric acid (AN) production</td><td>Considering ATOME's nitric acid (AN) plant with dual-pressure production technology, where absorption takes place at a higher pressure than the oxidation stage of NH3 and nitrogen gases, together with a NOx reduction system in the tail gas, the following values are obtained for use in calculations:
• EF = 2.5 kg N2O/t AN produced with dual medium/high pressure technology and NOx reduction technology</td><td><u>N2O emissions from AN production</u>
$$E_{N2O} = EF \cdot NAP$$
Where:
E_{NO2} = N2O emissions, kg/year
EF = Emission of N2O factor (default), kg NO2/t AN produced</td><td><u>New AN plants (using the emission factor)</u>
EN2O = 380.6 t N2O/year
ECO2 = 380.6 t N2O/year *(296) = 112,664 CO2-eq/year[IX]</td><td>2019 IPCC guidelines for national greenhouse gas inventories.</td></tr>
</table>

[IX] 1 kg N2O = 296 kg CO2-eq; 1kg CH4 = 28 kg CO2-eq. Source: 100-year GWPs from IPCC Fourth Assessment Report (AR4), 2007

<table>
<tr><th>Source of Emission</th><th>Description</th><th>Methodology</th><th>Emissions</th><th>Reference</th></tr>
<tr><td></td><td>

- NAP = 435 t/day * 365 day/year = 152,250 t/year

In addition, data provided by the URBAS FEED are used:

- Tail gas pre-treated in the NOx reduction system: 58,212 Nm3/h (note[VIII])
- Composition: < 20 ppmv N2O, < 5 ppmv NH3, <10 ppmv NOx

For comparison, emission factors are used from plants currently in operation, such as the Borealis plant in Stenungsund, Sweden, which began operating in 1950.

= 10 kg N$EF_{2O/t}$ AN (Old AN plants)
</td><td>NAP = AN production, t/year</td><td>Ancient NA plants (using the emission factor)
$EN2O$ = 1,522.5 t N2O/year
$ECO2$ = 1,522.5 t N2O/year *(296) = 450,660 t CO2-eq/year

ATOME Plant (using FEED data)
$EN2O$ = 19.22 t N2O/year
$ECO2$ = 19.22 t N2O/year *(296) = 5,689 t CO2-eq/year</td><td>Volume 3 – Industrial Processes and Product Use</td></tr>
<tr><td>Production of SNA and CAN</td><td>

According to the 2006 IPCC Guidelines and the EMEP/CORINAIR Emission Inventory Guide, NOx, VOC, VOC and SOx emissions from ammonium nitrate solution (ANS) production and calcium ammonium nitrate (CAN) granulation are not expected to be significant. However, emissions from ammonium nitrate production plants typically consist of particulate matter (ammonium nitrate and coating materials), ammonia, and nitric acid. Ammonia and nitric acid are mainly emitted from the formation of solutions and granulators.

Table 8.3-2 (English Units). EMISSION FACTORS FOR PROCESSES IN AMMONIUM NITRATE MANUFACTURING PLANTS[a]

EMISSION FACTOR RATING: A (except as noted)

<table>
<tr><th rowspan="2">Process</th><th colspan="2">Particulate Matter</th><th>Ammonia</th><th>Nitric Acid</th></tr>
<tr><th>Uncontrolled (lb/ton Of Product)</th><th>Controlled[b] (lb/ton Of Product)</th><th>Uncontrolled[c] (lb/ton Of Product)</th><th>Controlled[d] (lb/ton Of Product)</th></tr>
<tr><td>Neutralizer</td><td>0.09 - 8.6[c]</td><td>0.004 - 0.43[d]</td><td>0.86 - 36.02[d]</td><td>0.084 - 2[d,e]</td></tr>
<tr><td>Evaporation/concentration operations</td><td>0.52</td><td>ND</td><td>0.54 - 33.4</td><td>ND</td></tr>
<tr><td>Solids formation operations</td><td></td><td></td><td></td><td></td></tr>
<tr><td>High density prill towers</td><td>3.18</td><td>1.20</td><td>57.2</td><td>ND</td></tr>
<tr><td>Low density prill towers</td><td>0.92</td><td>0.52</td><td>0.26</td><td>ND</td></tr>
<tr><td>Rotary drum granulators</td><td>392</td><td>0.44</td><td>59.4</td><td>ND</td></tr>
<tr><td>Pan granulators</td><td>2.68</td><td>0.04</td><td>0.14</td><td>ND</td></tr>
<tr><td>Coolers and dryers[f]</td><td></td><td></td><td></td><td></td></tr>
<tr><td>High density prill coolers</td><td>1.6</td><td>0.02</td><td>0.04</td><td>ND</td></tr>
<tr><td>Low density prill coolers</td><td>51.6</td><td>0.52</td><td>0.30</td><td>ND</td></tr>
<tr><td>Low density prill dryers</td><td>114.4</td><td>1.14</td><td>0 - 3.18</td><td>ND</td></tr>
<tr><td>Rotary drum granulator coolers</td><td>16.2</td><td>0.16</td><td>ND</td><td>ND</td></tr>
<tr><td>Pan granulator coolers</td><td>36.6</td><td>0.36[d]</td><td>ND</td><td>ND</td></tr>
<tr><td>Coating operations[g]</td><td>≤ 4.0[d]</td><td>≤ 0.04[d]</td><td>NA</td><td>NA</td></tr>
<tr><td>Bulk loading operations[g]</td><td>≤ 0.02[d]</td><td>ND</td><td>NA</td><td>NA</td></tr>
</table>

[a] Some ammonium nitrate emission factors are based on data gathered using a modification of EPA Method 5 (See Reference 1). ND = no data. NA = not applicable.
[b] Based on the following control efficiencies for wet scrubbers, applied to uncontrolled emissions: neutralizers, 95%; high density prill towers, 62%; low density prill towers, 43%; rotary drum granulators, 99.9%; pan granulators, 98.5%; coolers, dryers, and coaters, 99%.
[c] Given as ranges because of variation in data and plant operations. Factors for controlled emissions not presented due to conflicting results on control efficiency.
[d] Based on 95% recovery in a granulator recycle scrubber.
[e] EMISSION FACTOR RATING: B.
[f] Factors for coolers represent combined precooler and cooler emissions, and factors for dryers represent combined predryer and dryer emissions.
[g] Fugitive particulate emissions arise from coating and bulk loading operations.
</td><td>

CAN Production Emissions:

- Without the application of the BATs (Best available technology): [5]

Air emissions can be up to 200 mg/particulate matter (PM) and NH3 (2 kg/t of product)

- Application of BAT:

Production of NA when insoluble solids are present, including the production of CAN:

  - 50 mg PM/Nm3
  - 50 mg NH3/Nm3
  - Production of NA when insoluble solids are present, including the production of CAN:
  - Granulation and prill towers with molten NA particles: 15 mg PM/Nm3 and 10 mg NH3/Nm3
  - Other individual emission points: 30 mg PM/Nm3 and 50 mg NH3/Nm3

ATOME Emissions

- SNA Plant
  - Flow rate 220,000 Nm3/h
  - Composition <50 mg/Nm3, <50mg/Nm3
- SNA Plant
</td><td>$ECO2$ = 0 t CO2-eq/year</td><td>https://www3.epa.gov/ttnchie1/ap42/ch08/final/c08s03.pdf
AP-42, CH 8.3: Ammonium Nitrate</td></tr>
</table>

[VIII] Normal cubic meter per hour. Refers to normal conditions of 0°C and 1 atm (1 atmosphere = 101,325 kPa)

Source of Emission	Description	Methodology	Emissions	Reference
	According to the information provided by SNA/CAN plants in Europe, it is estimated that N emissions [4]2O from nitric acid production accounted for between 60% and 78% of total CO2 emissions-eq from the production of SNA/CAN. It is estimated that the production of 220,750 t/year of 95% SNA and the production of 250,000 t/year of CAN without greenhouse gas emissions into the atmosphere are estimated, according to URBAS/Casale.	o Flow rate t.b.d o Dust content <50 mg/Nm3		
Employee travel for plant operation	The CO2, CH4 and N2O emissions of the transport contracted for the operation of the plant are estimated using the same technologies applied to the mobile sources. The following assumptions are used to calculate emissions: • For ammonia production, 50 contract people directly related to the operational process will be needed, and for producing CAN, an additional 40 contract people will be needed. • Preliminarily, the connection between the Asunción Bus Terminal (Ave Fernando de la Mora, Asunción) and the central one is estimated through the Villeta-Alberdi Route, with intermediate stops to be defined in later phases. The travel distance is 55 km, and another 55 km for the return, totaling 110 km per full trip. • Assuming it runs 24/7 for 12 months of the year, there are 365 trips per vehicle per year. The total distance per vehicle is 110 km/trip * 365 trips per year = 40,150 km per year per vehicle. • In the case of buses, it is estimated that there are 30 seated passengers, requiring 2 buses for ammonia production and 2 additional buses for CAN production expansion at the ATOME plant. • Average fuel consumption is 30 litres per 100 km. The emission factors (FEs) for diesel vehicles are: • *EFCO2* = 74,100 kg/TJ • *EFCH4* = 9.5 kg/TJ • *EFN2O* = 12 kg/T	GHGs emitted by the transport of raw materials. $$Emissions = \sum (Fuel_{ij} \cdot EF_{ij})$$ Where: *Transmissions* = GHG (kg) *Fueli,j* = fuel consumed (TJ) *EFi,j* = emission factor (kg/TJ) i = type of vehicle/machinery j = fuel type Calculation of the estimated fuel for the transport of raw materials. $$Estimaded\ fuel = \sum_{i,j,t} [Vehicle_{i,j,t} \cdot Distance_{i,j,t} \cdot Consumption_{i,j,t}]$$ Where: *Estimated fuel* = estimated total fuel consumption based on distance traveled (KRV) data *Vehiclesi,j,t* = Number of type i vehicles using type j fuel on type t $road$ *Distancei,j,t* = Annual kilometres travelled by type i vehicles using type j fuel on type t $road$ (km) *Consumptioni,j,t* = average fuel consumption (L/km) of type i vehicles using type j fuel on type t $road$ i = type of vehicle (e.g. car, bus) j = fuel type (e.g. gasoline, diesel, natural gas, LPG) t = type of road (e.g. urban, rural)	a) Ammonia Production: *Estimated fuel* = 24,090 L/year *Fuel* = 0.86 TJ/year[X] Emissions: • CO2 = 64.01 t/year • CH4 = 8.17e-03 t/year • N2O = 0.010 t/year *E* = 64.01*(1) + 8.17e-03*(28) + 0.010*(296) = 67.2 t CO2-eq/year 1. CAN Production: *Estimated fuel* = 48,180 L/year *Fuel* = 1.73 TJ/year Emissions: • CO2 = 128.2 t/year • CH4 = 0.016 t/year • N2O = 0.021 t/year *E* = 128.2*(1) + 0.016*(28) + 0.021*(296) = 134.86 t CO2-eq/year	2006 IPCC guidelines for national greenhouse gas inventories. Volume 2 - Energy: Mobile Combustion

[X] 35.86 MJ/L

Scope 2

Indirect emissions from purchased services. Scope 2 emissions are indirect emissions originating from the generation of purchased electric, heating, cooling, gas, steam and purchased electric vehicle services.

Source of Emission	Description	Methodology	Emissions	Reference
Activities that involve the burning of fossil fuels (generation of electricity from stationary combustion)	Ammonia and CAN production plants in European countries, the main consumers and producers of CAN, consume electricity derived from the burning of fossil fuels. Emissions resulting from electricity consumption shall be accounted for according to the quantity and type of fuel used. Using the following estimate of the distribution of electricity consumption at the ATOME plant: • H2 plant, 110 MW • Air Separation Unit, 2 MW • NH3 plant, 8 MW • AN, SNA and CAN plant, 1.4 MW • Turbine, -2.9 MW[XI] • Balance of Plant, 6 MW It can be assumed that European plants do not use electrolysers for hydrogen production, which reduces the electricity consumption of the hydrogen plant to 2 MW (mainly for operation with compressors). When adding the other demands, the total power required amounts to 18 MW. Therefore: • *Fuel consumption* = 18 MW*365 day/year * 24 h/day = 157,680 MWh/year or 567.64 TJ/year for the regular operation of an ammonia and CAN plant. Default emission factors for stationary combustion in energy industries (kg GHG/TJ). Natural gas: • *EFCO2,fuel*= 56,100 kg CO2/TJ • *EFCH4,fuel*= 1 kg CH4/TJ	Total GHG emissions $Emissions_{GHG} = \sum_{fuel} Emission_{GHG,fuel}$ GHG emissions from stationary combustion $Emissions_{GHG,fuel} = Consumption_{fuel} \cdot EF_{GHG,fuel}$ Where: *EmissionsGHG,fuel*= Emissions of a given GHG by fuel type, kg GHG/year *Consumptionfuel* = Amount of fuel burned, TJ/year *EFGHG,fuel* = default emission factor of a given GHG per fuel type, kg GHG/TJ	Annual greenhouse gas emissions from the consumption of fuels for electricity generation • *ECO2,fuel* = 31,844.6 t CO2/year • *ECH4,fuel* = 0.56 t CH4/year • *EN2O,fuel* = 0.056 t N2O/year Total annual CO2-eq emissions from the consumption of fuels for electricity generation. *EmissionsGHG* = 31,884.6*(1) + 0.56*(28) + 0.056*(296) = 31,916.8 t CO2-eq/year	2006 IPCC guidelines for national greenhouse gas inventories. Volume 2 - Energy: Stationary Combustion

[XI] Within the process of the nitric acid plant, it is possible to use the produced water vapor for the generation of electricity and supply the electrical components of the plant, resulting in the self-supply of electrical energy

Source of Emission	Description	Methodology	Emissions	Reference
	• *EFN2O,fuel*= 0.1 kg N2O/TJ			
Fugitive emissions from fossil fuel production	The term "fugitive emissions" is broadly applied, referring to all greenhouse gas emissions originating from the natural gas production and processing system (from the infrastructure necessary to produce, harvest, process, or refine and bring natural gas to market). The most important sources of fugitive emissions include equipment leaks, evaporation and losses from discharge, venting, burning, incineration, and accidental releases. The methodology consists of applying default emission factors corresponding to a representative parameter of activity (usually production) for each segment or subcategory applicable to the natural gas industry of the country/region. More than 40% of Europe's natural gas comes from Russia. To produce 250,000 t CAN/year, 157,680 MWh/year are required, which is equivalent to 13.47e06^{m3} per year[XII] The average emission factors for the most significant industry activities and segments are considered: • Gas production, t/1e06 m3: Fugitive EFCO2 = 4.8e-05, EFCH4 = 1.34e-03, EFCOVDM = 3.2e-04; Torch: EFCO2 = 1.2e-03, EFCH4 = 7.6e-07, EFCOVDM = 6.2e-04, EFNOx = 2.1e-08. • Gas processing, t/1e06 m3: Fugitive EFCO2 = 1.66e-04, EFCH4 = 5.9e-04, EFCOVDM = 3.05e-04; Torch: EFCO2 = 3e-03, EFCH4 = 2.0e-06, EFCOVDM = 1.6e-06, EFNOx = 3.3e-08. • Gas transport and storage, t/1e06 m3: Fugitive EFCO2 = 8.8e-04, EFCH4 = 2.73e-04, EFCOVDM = 7.0e-06; Venting EFCO2 = 3.1e-06, EFCH4 = 4.6e-04, EFCOVDM = 4.6e-06; Storage: EFCO2 = 1.1e-07, EFCH4 = 2.5e-05, EFCOVDM = 3.6e-07. • Gas distribution, t/1e06 m3: EFCO2 = 5.1e-05, EFCH4 = 1.1e-03, EFCOVDM = 1.6e-05.	Estimation of fugitive emissions from an industry segment. $$E_{gas,segment} = A_{segment} \cdot EF_{gas,segment}$$ Where: *Egas, segment* = annual GHG emission factor, t/year *EFgas, segment* = GHG emission factor, t/activity *Asegment* = type of activity (e.g. annual production of m3) Total Fugitive Emissions from Industries $$E_{gas} = \sum_{industry} E_{gas,industry}$$	Fugitive emissions of: • Gas production, 0.46 t CO2-eq/year • Gas processing, 0.24 t CO2-eq/year • Gas transport and storage, 0.26 t CO2-eq/year • Gas distribution, 0.37 t CO2-eq/year Total Fugitive Emissions E_{gas} = 1.33 t CO2-eq/year	2019 IPCC guidelines for national greenhouse gas inventories. Volume 2 - Energy: Fugitive Emissions.
Renewable energy	Electricity generation from renewable sources generally has negligible or lower emissions, except in the case of hydropower with large reservoir storage capacity. River waters naturally emit greenhouse gases (GHGs),	GHG from hydroelectric reservoirs: $$E_{CO2e}\ (t/año) = Wh \cdot EF$$ Where:	E_{CO2e} = 24,228.8 t CO2-eq/year	EIB Project Carbon Footprint

[XII] Each cubic meter (m3) of natural gas corresponds to a Higher Heating Value (HHV) of 11.70 kWh.

Source of Emission	Description	Methodology	Emissions	Reference
	but the construction of reservoirs for hydropower alters carbon emission and storage, releasing CO2 and CH4 generated by the decomposition of submerged organic matter and vegetation. These gases are emitted through diffusion, boiling, and other mechanisms. Hydropower plants with power density indicator, PDI (reservoir capacity/area) in a range of 4 and 10 W/m2 can use current methodologies, with an average emission factor of 24 g CO2-eq/kWh for reservoir emissions[XIII]. The methodology applied is based on the use of emission factors and installed capacity. In this case, the energy required for the normal operation of the ATOME plant will be used. The data used are as follows: • Wh = 120 MW * 24 h/day * 365 day/year = 1,051,200 MWh/year • EF = 24 g CO2-eq/kWh = 0.024 t CO2-eq/MWh Itaipu, with an installed capacity of 14,000 MW, has a reservoir with an area of 1.3e-9 m2 (135,000 ha) [XIV]and its Power Density Index (PDI) is 10.37 W/m2	$E_{CO2e}\ (t/año)$ = Annual GHG emissions, t/year Wh = Energy produced annually, MWh/year EF = Emission factor, t CO2-eq/MWh		Methodologies – Methodologies for the assessment of project greenhouse gas emissions and emission variations [EIB Project Carbon Footprint Methodologies]

Scope 3

- Upstream activities: Materials directed to the factory, goods and services purchased, waste generated in operations, transportation and distribution, business travel, employee travel, leased assets, fuel and energy related activities, capital goods.
- Downstream activities: Transportation and distribution, processing of products sold, use of products sold, end-of-life treatment, leased assets, franchising, investments.

Source of Emission		Description	Methodology	Emissions	Reference
Upstream activities: indirect greenhouse gas emissions related to purchased	Emissions from the Construction Phase – Land	CO2 emissions from land-use changes are mainly due to deforestation and land conversion for agriculture, urban areas, urbanization, roads, etc. When large tracts of tropical forests are cleared, the land is often transformed into less productive grasslands with considerably reduced capacity for carbon storage. In the case of ATOME, with 30 hectares of land acquired for the installation of the plant, this does not constitute a significant contribution. In addition, the following methodology is presented which provides a simplified approach to estimating emissions on the basis of cleared area and IPCC default values for above-ground and groundwater carbon stocks in various vegetation types.	The annual loss of carbon in biomass due to disturbances is calculated using the equation: $L_{disturbance} = \{A_{disturbance} \cdot B_W \cdot (1+R) \cdot CF \cdot fd\}$ Where: *Ldisturbance* = Annual carbon loss, t C/year *Adisturbance* = Area affected by disturbances, ha/year *Bw* = average aboveground biomass of the disturbed land area, t dm/ha	$E_{disturbance}$= 4,290 t CO2/year $E_{organic}$ = 40.8 t CO2/year Total annual CO2 emissions due to land-use change E = 4,330.8 t CO2/year	https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-08-v3.pdf

[XIII] It is stated that "The IPCC states that hydropower has an average greenhouse gas (GHG) emission intensity of 24 g CO_2-eq/kWh" Hydropower.org

[XIV] https://www.itaipu.gov.py/es/sala-de-prensa/itaipu-en-numeros

Source of Emission		Description	Methodology	Emissions	Reference
goods and services	Use Change	• *Adisturbance* = *A* = 30 ha • Soil domain classification: Humid subtropical, body weight = 220 t dm/ha. • *FD* = 1 (plant installation replaces all biomass) • *CF* = 0.5 t C/t d.m. • *R* = 0.3 t d.m. of groundwater biomass (t d.m. aboveground biomass)$^{-1}$ • *EFc* = 1.36 t CO2/ha-year for tropical climate soils	*R* = Ratio of groundwater biomass to aboveground biomass, in t d.m. groundwater biomass (t d.m. aboveground biomass)$^{-1}$ *CF* = carbon fraction of dry matter, t C/t dry matter *fd* = fraction of biomass lost due to disturbances Increased CO2 emissions due to loss of biomass in existing vegetation as a result of site preparation, t CO2/year: $$E_{disturbance} = L_{disturbance} \cdot \frac{44}{12}$$ The annual loss of soil carbon is calculated using the equation: $$L_{organic} = \sum_{c} (A \cdot EF)_c$$ Where: *Lorganic* = Annual carbon loss from drained organic soils, t C/year *A* = Soil surface at climate type c, ha *EF* = Emission factor for climate type c, t C/ha-year Increased CO2 emissions due to soil carbon shift as a result of site preparation; t CO2/year. $$E_{organic} = L_{organic} \cdot \frac{44}{12}$$		2006 IPCC guidelines for national greenhouse gas inventories. Volume 4 - Agriculture, Forestry and Other Land Uses: Chapter: Generic Methodologies Applicable to Multiple Land Use Categories and Chapter: Forest Land Use
	Emissions from the construction stage: materials, assembl	The chosen methodology provides an approach to estimate greenhouse gas emissions from building construction activities as a function of the total area of buildings, using the concept of "embodied carbon". This concept represents the tons of greenhouse gas emissions throughout the life cycle of building materials, including extraction, manufacturing, processing, transportation, construction, disposal, assembly, and the overall life cycle. Concrete, steel, and insulation are examples of materials that contribute to embodied carbon emissions and account for more than 25% of emissions[XV,XVI,XVII] For the ATOME plant, the following buildings have been identified, as well as their estimated surface area[XVIII]:	GHG emissions over the lifetime of each building $$ECO_2e(t) = \sum_{i} [AS_i \cdot (EF_i)]$$ Where: *ECO2e* = Emission of greenhouse gases emitted during the life cycle of buildings, kg CO2-eq *ASi* = Building area for building type i, m2 *EFi* = Emission factor for the surface area of the type i *building*, kg/m2	Ammonia production • H2 plant, *ECO2ei* = 2,423.86 t CO2-eq • Office building, *ECO2ei* = 153 t CO2-eq • Staff building, *ECO2ei* = 141.12 t CO2-eq • Warehouse, *ECO2ei* = 447.29 t CO2-eq	2006 IPCC guidelines for national greenhouse gas inventories. Volume 1 - General Guidance and Reporting

[XV] Gao, T., Shen, L., Shen, M., Chen, F., Liu, L., Gao, L., 2015. Analysis on differences of carbon dioxide emission from cement production and their major determinants. J. Clean. Prod. 103, 160-170

[XVI] Labaran YH, Mathurb VS, Farouq MM. The carbon footprint of construction industry: A review of direct and indirect emission. J Sustain Const Mater Technol 2021; 6:3:101–115.

[XVII] Sizirici B, Fseha Y, Cho CS, Yildiz I, Byon YJ. A Review of Carbon Footprint Reduction in Construction Industry, from Design to Operation. Materials (Basel). 2021 Oct 15; 14(20):6094. doi: 10.3390/MA14206094. PMID: 34683687; PMCID: PMC8540435.

[XVIII] These values are only approximate estimates and serve only to measure the carbon footprint.

<table>
<tr><th colspan="2">Source of Emission</th><th>Description</th><th>Methodology</th><th>Emissions</th><th>Reference</th></tr>
<tr><td rowspan="2"></td><td>y, and construction activities</td><td>

- Hydrogen plant, 7,072.5 m2
- Office building, 382.5 m2
- Staff building, 352.8 m2
- Warehouse, 1,118.23 m2
- Granulation plant, 2,500 m2
- Raw material storage, 2,475 m2
- CAN storage, 26,950 m2.

Emission factors were obtained from Life Cycle Assessment (LCA) modelling studies based on databases of industrial buildings with different surfaces. These factors span the entire life cycle of building materials, from their manufacture to their end use or service life. For this analysis, only the following emission factors were considered, focusing on:

- Production phase (including procurement of raw materials, transportation to the production plant, and manufacturing of products),
- Erection/erection phase (including site preparation, construction of on-site foundations, and assembly of materials/buildings), and
- Transport phase (including finished products, raw materials and machinery to/from the assembly site).

The use phase and the end-of-life phase were not considered due to the inclusion of energy and electricity consumption factors. The data covers cases of industrial buildings built in European countries where non-renewable energy sources are commonly used. The inclusion of this phase would affect the overall CO2 balance of the ATOME plant, as this phase would contribute 76% to total GHG emissions. In addition, the dismantling of the structure, which is not included in the useful life of the plant, is also contemplated.

The emission factors related to the surface area of each building in square meters were obtained from the empirical data of the reference[XIX].

<table>
<tr><th>Floor area (m^2)</th><th>1048</th><th>3000</th><th>12,720</th><th>21,910</th></tr>
<tr><td colspan="5">Carbon Footprint (CF) (tCO_{2eq})</td></tr>
<tr><td>1. Plant production</td><td>478.2</td><td>1040</td><td>4216</td><td>5370</td></tr>
<tr><td>2. On-site assembly</td><td>3.035</td><td>7.215</td><td>25.59</td><td>41.54</td></tr>
<tr><td>3. Transportation</td><td>9.974</td><td>21.64</td><td>61.32</td><td>109.0</td></tr>
<tr><td>4. Use</td><td>1,049</td><td>3,004</td><td>12,735</td><td>21,936</td></tr>
<tr><td>5. End-of-life</td><td>−24.77</td><td>−51.87</td><td>−179.9</td><td>−367.8</td></tr>
<tr><td>Total</td><td>1516</td><td>4021</td><td>16,858</td><td>27,089</td></tr>
</table>

</td><td>i= Type of building</td><td>

ECO2-eq = 3,165.27 t CO2-eq

<u>Production of AN, SNA and CAN</u>

- Granulation plant, *ECO2ei* = 890.71 t CO2-eq
- Feedstock storage, *ECO2ei* = 881.8 t CO2-eq
- CAN storage, *ECO2ei* = 6,790.44 t CO2-eq

ECO2-eq = 11,728.2 t CO2-eq

</td><td></td></tr>
<tr><td>Transmission Line</td><td>The construction of transmission line infrastructure can lead directly to GHG emissions due to factors such as fuel consumption (gasoline, diesel, etc.) and indirectly through construction materials (cement, steel, etc.) and electrical equipment (cables, transformers, suspension clamp fittings, etc.).</td><td>

<u>Greenhouse gas emissions associated with the construction of transmission line infrastructure</u>

$$E = EF \times AD$$

Where:

E = GHG emissions, t CO2-eq

</td><td>E = 159.6 t CO2-eq</td><td>Wei, W., Wang, M., Zhang, P. et al. A 2015 inventory of embodied</td></tr>
</table>

[XIX] Bonamente, E.; Cotana, F. Carbon and Energy Footprints of Prefabricated Industrial Buildings: A Systematic Life Cycle Assessment Analysis. Energies 2015, 8, 12685-12701. https://doi.org/10.3390/en81112333

Source of Emission		Description	Methodology	Emissions	Reference
		In similar large-scale projects, such as the ATOME project, it is observed that emissions indirectly related to materials account for 75% of total emissions, 12% for installation and engineering, and 15% for additional services. Among the construction materials used, steel products for the production and erection of towers, as well as transmission cables, are the largest contributors to indirect emissions, at 59% and 21%, respectively. The emission factor to be used was obtained from an inventory of transmission line projects with similar characteristics to the ATOME project. The following considerations were used for the breakdown of project-related emissions: • Project Land Type: Flat Land • Project voltage: The transmission infrastructure for the project is 220 kV • Transmission Line Circuit Style: There are two types of transmission lines for all voltage classes: single circuit and double circuit. The first option was chosen because of its common use in projects. • Transmission line length: The distance between the Buey Rodeo and Atome substations is < 1 km. The emission factor considering these characteristics is *EF* = 159.6 t CO2-eq/km. Other reports indicate that emissions related to 220 kV transmission line projects have an emission factor of 190 t CO2-eq/km[XX].	*EF* = Emission factor, t CO2-eq/km *AD* = Activity data, km		carbon emissions for Chinese power transmission infrastructure projects. Sci Data 7, 318 (2020). https://doi.org/10.1038/s41597-020-00662-4
	Emissions from vehicles and equipment used during construction	CO2, CH4 and N2O emissions from off-road vehicles and machinery are estimated using the same technologies applied to mobile sources. Types of engines that are typically used include compression-ignition (diesel) engines, spark-ignition (gasoline) engines, 2-stroke engines, and 4-stroke gasoline engines. The following assumptions are made: • A fleet of 25 trucks for transporting material for filling, with a working duration of 40 days, making 8 round trips per truck per day, with total trips equal to 7750. The backfill material will be transported from a quarry in Surubi'y to the plant via the Villeta-Alberdi Route (15 km). • The engine types are compression-ignition (diesel), with an average consumption of 40 L per 100 km. • Emissions are estimated using predetermined fuel-specific emission factors, as shown in the table below: *EFCO2* = 74,100 kg/TJ, *EFCH4* = 1.67 kg/TJ, *EFN2O* = 14.3 kg/TJ	<u>Emissions emitted during the construction and commissioning period of the plant:</u> $$Emissions = \sum (Fuel_{ij} \cdot EF_{ij})$$ Where: *Emissions* = GHG emissions (kg) $Fuel_{ij}$ = Fuel consumed (TJ) $EF_{i,j}$ = Emission factor (kg/TJ) *i* = Type of vehicle/machinery *j* = Fuel type <u>Calculation of the estimated fuel for the construction and commissioning period of the plant:</u> $$Estimated\ fuel = \sum_{i,j,t} [Vehicle_{i,j,t} \cdot Distance_{i,j,t} \cdot Consumption_{i,j,t}]$$ Where:	<u>Trucks for backfilling (40 days):</u> *Estimated fuel* = 96,000 L *Fuel* = 3.44 TJ[XXI] *Emissions:* • CO2 = 254.9 t • CH4 = 5.74e-03 t • N2O = 0.049 t Total Emissions: *E* = 254.9*(1) + 5.74e-03*(28) + 0.049*(296) = 269.56 t CO2-eq <u>Container Transport Trucks (Estimated Trips Used):</u> *Estimated fuel* = 2700 L *Fuel* = 0.096 TJ *Emissions:* • CO2 = 239.15 t • CH4 = 0.030 t	IPCC guidelines for 2019 national greenhouse gas inventories. Volume 2 – Energy: Mobile Combustion

[XX] (PDF) Embodied greenhouse gas emissions from building China's large-scale power transmission infrastructure (researchgate.net)

[XXI] 35.8 MJ/L

Source of Emission		Description	Methodology	Emissions	Reference

CUADRO 3.3.1
FACTORES DE EMISIÓN POR DEFECTO PARA LAS FUENTES Y MAQUINARIA MÓVILES TODO TERRENO [a]

	CO_2			CH_4 [b]			N_2O [c]		
Fuente todo terreno	Por defecto (kg/TJ)	Inferior	Superior	Por defecto (kg/TJ)	Inferior	Superior	Por defecto (kg/TJ)	Inferior	Superior
Diesel									
Agricultura	74 100	72 600	74 800	4,15	1,67	10,4	28,6	14,3	85,8
Silvicultura	74 100	72 600	74 800	4,15	1,67	10,4	28,6	14,3	85,8
Industria	74 100	72 600	74 800	4,15	1,67	10,4	28,6	14,3	85,8
Hogares	74 100	72 600	74 800	4,15	1,67	10,4	28,6	14,3	85,8
Motor de 4 tiempos a gasolina									
Agricultura	69 300	67 500	73 000	80	32	200	2	1	6
Silvicultura	69 300	67 500	73 000						
Industria	69 300	67 500	73 000	50	20	125	2	1	6
Hogares	69 300	67 500	73 000	120	48	300	2	1	6
Motor de 2 tiempos a gasolina									
Agricultura	69 300	67 500	73 000	140	56	350	0,4	0,2	1,2
Silvicultura	69 300	67 500	73 000	170	68	425	0,4	0,2	1,2
Industria	69 300	67 500	73 000	130	52	325	0,4	0,2	1,2
Hogares	69 300	67 500	73 000	180	72	450	0,4	0,2	1,2

CO2, CH4 and N2O emissions from heavy-duty trucks are estimated using the same technologies applied to mobile sources. The following assumptions are used to calculate emissions:

- A fleet of 5 heavy trucks is used to transport containers with imported goods. The operation is intermittent over 5 months, depending on arrivals at the ports of Villeta. For every arrival, there are 20 truck trips, for a total of 450 trips. These trips are to receive imported goods, traveling from Puerto Terport to the plant through the Villeta-Alberdi Route (15 km).
- Another set of at least 5 truck trips per day from various locations within Paraguay for 10 months is considered. The travel distance for each trip is estimated within a range of 15 to 600 km.
- The engines are spark-ignition and compression-ignition diesel engines, with an average fuel consumption of 40 L per 100 km.
- Emissions are estimated using the default emission factors for diesel engines, as shown in the table below. *EFCO2* = 74,100 kg/TJ, *EFCH4* = 9.5 kg/TJ, *EFN2O* = 12 kg/TJ

CUADRO 3.2.1
FACTORES DE EMISIÓN DE CO_2 POR DEFECTO DEL TRANSPORTE TERRESTRE Y RANGOS DE INCERTIDUMBRE [a]

Tipo de combustible	Por defecto (kg/TJ)	Inferior	Superior
Gasolina para motores	69 300	67 500	73 000
Gas/Diesel Oil	74 100	72 600	74 800
Gases licuados de petróleo	63 100	61 600	65 600
Queroseno	71 900	70 800	73 700
Lubricantes [b]	73 300	71 900	75 200
Gas natural comprimido	56 100	54 300	58 300
Gas natural licuado	56 100	54 300	58 300

Fuente: Cuadro 1.4 del capítulo Introducción del Volumen Energía.
Notas:
[a] Los valores representan el 100 por ciento de oxidación del contenido de carbono del combustible.
[b] Véase el Recuadro 3.2.4 Lubricantes en la combustión móvil para obtener una orientación acerca de los usos de los lubricantes.

CUADRO 3.2.2
FACTORES DE EMISIÓN POR DEFECTO DE N_2O Y CH_4 DEL TRANSPORTE TERRESTRE Y RANGOS DE INCERTIDUMBRE [a]

Tipo de combustible / Categoría representativa de vehículo	CH_4 (kg/TJ)			N_2O (kg/TJ)		
	Por defecto	Inferior	Superior	Por defecto	Inferior	Superior
Gasolina para motores – sin controlar [b]	33	9,6	110	3,2	0,96	11
Gasolina para motores – catalizador de oxidación [c]	25	7,5	86	8,0	2,6	24
Gasolina para motores – vehículo para servicio ligero con poco kilometraje, modelo 1995 o más nuevo [d]	3,8	1,1	13	5,7	1,9	17
Gas / Diesel Oil [e]	3,9	1,6	9,5	3,9	1,3	12
Gas natural [f]	92	50	1 540	3	1	77
Gas licuado de petróleo [g]	62	na	na	0,2	na	na
Etanol, camiones Estados Unidos [h]	260	77	880	41	13	123
Etanol, automóviles, Brasil [i]	18	13	84	na	na	na

Estimated fuel = Total fuel consumption estimated from distance traveled (KRV) data
$Vehicle_{i,j,t}$ = Number of type i vehicles using type j fuel on type t road.
$Distance_{i,j,t}$ = Annual kilometres travelled by type i vehicle using type j fuel on type t road, km
$Consumption_{i,j,t}$ = Average fuel consumption, L/km, per type i vehicle using type j fuel on type t *highway*
i = Type of vehicle (e.g. car, bus).
j = fuel type (e.g. motor gasoline, diesel, natural gas, LPG)
t = type of road (e.g. urban, rural).

- N2O = 0.038 t

E = 239.15*(1) + 0.030*(28) + 0.038*(296) = 251.24 t CO2-eq

Other trucking activities (a range of estimated trips is used):
Estimated fuel = 300 – 12,000 L
Fuel =0.011 – 0.43 TJ
Emissions:

- CO2 = 0.81 – 31.86 t
- CH4 = 1.0e-04 – 4.0e-03 t
- N2O = 1.32e-04 – 5.16e-03 t

E = 0.85 – 33.5 t CO2-eq

Total GHG emissions:
ECO2e-total = 521.65 – 554.3 t CO2-eq

<table>
<tr><th colspan="2">Source of Emission</th><th>Description</th><th>Methodology</th><th>Emissions</th><th>Reference</th></tr>
<tr><td rowspan="3"></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Employee travel during the construction phase</td><td>CO2, CH4 and N2O emissions are estimated from the transport contracted for the operation of the plant using the same technologies applied to mobile sources. The following assumptions are used to calculate emissions:
• Approximately 400 contract personnel directly related to the construction phase will be needed to produce NH3 and CAN.
• Preliminarily, the connection between the Asunción Bus Terminal (Av. Fernando de la Mora, Asunción) and the plant is estimated through the Villeta-Alberdi Route, with intermediate stops that will be defined in later phases. The distance to be covered is 55 km one way and 55 km back, totaling 110 km per trip. For a total of 22 months of work, an estimated 116 trips are projected – see table below. Total distance of the construction phase: 12,760 km.
Autobuses: viajes de autobús ida y vuelta al día:
<table>
<tr><td>MES</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td></tr>
<tr><td>Autobuses</td><td>1</td><td>1</td><td>2</td><td>4</td><td>4</td><td>4</td><td>4</td><td>4</td><td>4</td><td>4</td><td>4</td><td>4</td><td>4</td><td>4</td><td>4</td><td>4</td><td>4</td><td>4</td><td>4</td><td>4</td><td>4</td><td>4</td></tr>
<tr><td>Viajes ida y vuelta</td><td>1</td><td>1</td><td>2</td><td>4</td><td>4</td><td>4</td><td>5</td><td>6</td><td>7</td><td>7</td><td>8</td><td>8</td><td>8</td><td>8</td><td>7</td><td>6</td><td>6</td><td>6</td><td>6</td><td>4</td><td>4</td><td>4</td></tr>
</table>
• Average fuel consumption of 30 litres per 100 kilometres.
The emission factors (EFs) of diesel vehicles are:
• EFCO2 = 74,100 kg/TJ
• EFCH4 = 9.5 kg/TJ
• EFN2O = 12 kg/T</td><td><u>Greenhouse gas emissions emitted from the transport of raw materials</u>
$$Emissions = \sum (Fuel_{ij} \cdot EF_{ij})$$
Where:
Emissions = GHG emissions, kg
$_{Fuel,j}$= Fuel consumed, TJ
EFi,j = Emission factor, kg/TJ
i = Type of vehicle/machinery
j = Fuel type

<u>Calculation of estimated fuel consumption for the transport of raw materials</u>
$$Estimated\ fuel = \sum_{i,j,t} [Vehicle_{i,j,t} \cdot Distance_{i,j,t} \cdot Consumption_{i,j,t}]$$
Where:
Estimated fuel = Total fuel consumption estimated from distance traveled (KRV) data
Vehiclei,j,t = Number of type i vehicles using type j fuel on the road type t.
Distancei,j,t = Annual kilometres travelled by type i vehicle using type j fuel on type t road, km
Consumptioni,j,t = Average fuel consumption, L/km, per type i vehicle using type j fuel on type t highway
i = Type of vehicle (e.g., car, bus).
j = fuel type (e.g. motor gasoline, diesel, natural gas, LPG)
t = Type of road (e.g., urban, rural).</td><td>Estimated fuel = 15,312 L
Fuel = 0.54 TJ[XXII]
Emissions:
• CO2 = 40.68 t
• CH4 = 5.13e-03 t
• N2O = 6.48e-03 t

E = 40.68*(1) + 5.13e-03*(28) + 6.48e-03*(296) = 42.74 t CO2-eq</td><td>IPCC (Intergovernmental Panel on Climate Change) Guidelines for National Greenhouse Gas Inventories, 2006. Volume 2 – Energy: Mobile Combustion</td></tr>
<tr><td>Goods and Services Purchased</td><td>Emissions of purchased goods, services and capital goods are a major source of emissions. The scope of this category focuses on the extraction, production, and transportation of goods and services procured or procured by ATOME. For this study, products will only include tangible goods (such as raw materials), and the transportation of purchased products is accounted for separately (upstream transportation and distribution).
The following assumptions are used to calculate emissions:
• Raw Materials:</td><td><u>GHGs associated with the production of raw materials.</u>
$$E = EF \times AD$$
Where:
E = GHG emissions, kg CO2-eq/year
EF = Emission factor, kg CO2-eq/kg
AD = Activity data, kg/year</td><td><u>Results:</u>
• PTA & WWTP 322.0 tCO2-eq/year
• H2 plant 6.85 tCO2-eq/year
• NH3 plant 116.3 tCO2-eq/year
• NA Plant 4,055.9 tCO2-eq/year</td><td>Ingwersen, W. AND M. Li. Supply Chain Greenhouse Gas Emission Factors for US Industries and Commodities.</td></tr>
</table>

[XXII] 35.8 MJ/L

<table>
<tr><th colspan="2">Source of Emission</th><th>Description</th><th>Methodology</th><th>Emissions</th><th>Reference</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><th>Process</th><th>Raw material</th><th>Value</th><th>Frequency/Years (hours)</th><th>EF (kgCO2-eq/kg)</th></tr>
<tr><td rowspan="2">WWTP</td><td>Sulfuric acid (96-98%)</td><td>2.55 kg/h</td><td>8400</td><td>0.1707</td></tr>
<tr><td>Sodium hydroxide (50%)</td><td>1 kg/h</td><td>8400</td><td>1.313</td></tr>
<tr><td rowspan="8">PTA</td><td>Coagulant – Aluminum Sulfate</td><td>8 kg/h</td><td>8400</td><td>0.667</td></tr>
<tr><td>Flocculant anionic polyamide</td><td>1.3 kg/h</td><td>8400</td><td>3.778</td></tr>
<tr><td>Sodium hydroxide</td><td>0.3 kg/h</td><td>8400</td><td>1.313</td></tr>
<tr><td>Sodium hypochlorite</td><td>2.3 kg/h</td><td>8400</td><td>2.61</td></tr>
<tr><td>Hydrochloric acid</td><td>0.7 kg/h</td><td>8400</td><td>0.9259</td></tr>
<tr><td>Polyelectrolyte</td><td>7.5 kg/h</td><td>8400</td><td>2.299</td></tr>
<tr><td>Antifouling</td><td>0.19 kg/h</td><td>8400</td><td>2.299</td></tr>
<tr><td>Sodium bisulfite</td><td>0.94 kg/h</td><td>8400</td><td>1.691</td></tr>
<tr><td>H2 Plant</td><td>KOH (30% w/w)</td><td>2,500 kg/year</td><td>1</td><td>2.74</td></tr>
<tr><td>NH3 Plant</td><td>AmoMax © catalyst. Zinc sulfide used as a proxy.</td><td>275,313 kg</td><td>0.2</td><td>2.112</td></tr>
<tr><td rowspan="4">AN & SNA Plant</td><td>Vanadium pentoxide</td><td>1.57 kg/day</td><td>1</td><td>166.16</td></tr>
<tr><td>Platinum Rhodium Base - Pt 29.63 kg</td><td>0.1482 kg/day</td><td>350</td><td>68,758.36</td></tr>
<tr><td>Platinum and rhodium base - Rh 1.56 kg</td><td>0.078 kg/day</td><td>350</td><td>79,687.61</td></tr>
<tr><td>Platinum Rhodium Base - Pd 13.92</td><td>0.0696</td><td>350</td><td>111,143.45</td></tr>
<tr><td rowspan="4">CAN Plant</td><td>Solid Granulating Agent</td><td>201.5 kg/h</td><td>7260</td><td>0.667</td></tr>
<tr><td>Liquid Glazing Agent - Siloxane</td><td>102.2 kg/h</td><td>7260</td><td>3.456</td></tr>
<tr><td>Liquid Coating Agent: Amine</td><td>40.8 kg/h</td><td>7260</td><td>2.784</td></tr>
<tr><td>Dolomite</td><td>173 t/day</td><td>330</td><td>See below</td></tr>
</table>
GHG estimates for limestone and crushed rock mining, based on a study for the U.S. Department of Energy, provide a breakdown of energy use by fuel type and electricity use[XXIII]. The estimates are shown below:
<table>
<tr><th>Power Consumption Unit</th><th>CO2 (g/ton)</th><th>CH4 (g/ton)</th><th>NO2 (g/ton)</th></tr>
<tr><td>Coal</td><td>88.54</td><td>0.099</td><td>0.011</td></tr>
<tr><td>Fuel oil (diesel)</td><td>1,684.2</td><td>1.88</td><td>0.011</td></tr>
<tr><td>Natural gas</td><td>318.8</td><td>0.886</td><td>0.006</td></tr>
<tr><td>Petrol</td><td>131.48</td><td>0.162</td><td>0.005</td></tr>
<tr><td>Net Electricity Purchased</td><td>1,884.16</td><td>0.047</td><td>0.035</td></tr>
</table>
For the calculations of dolomite/limestone mining emissions, only fuel oil and gasoline are considered, as electricity is assumed to be 100% renewable.

• Packaging:</td><td></td><td>
• CAN Plant 109,238.5 tCO2-eq/year
• Packaging 354.6 tCO2-eq/year

<u>NH3 Production Scenario</u>
Emissions: 445.15 tCO2-eq/year

<u>CAN Production Scenario</u>
Emissions: 110,026.25 tCO2-eq/year</td><td>U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-20/001, 2020</td></tr>
</table>

[XXIII] BCS, Inc. Energy and Environmental Profile of the U.S. Mining Industry. Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy, 2002.

<table>
<tr><th colspan="2">Source of Emission</th><th>Description</th><th>Methodology</th><th>Emissions</th><th>Reference</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><th>Process</th><th>Raw material</th><th>Value</th><th>Frequency/Years (hours)</th><th>EF (kgCO2-eq/kg)</th></tr>
<tr><td rowspan="2">CAN Plant</td><td>Polypropylene PP – 100gsm</td><td>0.5 kg/t CAN</td><td>250,000 t CAN</td><td>2.298</td></tr>
<tr><td>PP to Big Bag (Transformation)</td><td>0.5 kg/t CAN</td><td>250,000 t CAN</td><td>0.539</td></tr>
</table>
</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Transport of raw materials and inputs to the ATOME plant</td><td>
Two methodologies were proposed to calculate emissions from the transport and distribution of raw materials and supplies to the ATOME site. The choice between them is based on the complexity of the calculation and the availability of the data.
<u>Raw materials and inputs for the operation</u>
The methodology used consists of the use of a tabulated emission factor related to the emissions generated per tonne of the product transported. The emission factor (EF) was extracted from the Ecoinvent 3 database as follows:
1. 0.173 t CO2-eq/t-km for trucks (16-32 tonne truck, EURO 5),
2. 0.00935 t CO2-eq/t-km for container ships by sea
3. 0.04443 t CO2-eq/t-km for river barges.
Activity Data (AD) is obtained by calculating the annual consumption in tonnes of each raw material and inputs, and then multiplying it by the distance travelled from the point of origin to the ATOME site. The assumptions are summarized in the following table:
<table>
<tr><th>Process</th><th>Raw material</th><th>Value</th><th>Transport</th><th>Way</th><th>Distance, km</th></tr>
<tr><td rowspan="2">WWTP</td><td>Sulfuric acid (96-98%)</td><td>2.55 kg/h</td><td>Villeta to ATOME</td><td>Truck</td><td>30</td></tr>
<tr><td>Sodium hydroxide (50%)</td><td>1 kg/h</td><td>Villeta to ATOME</td><td>Truck</td><td>30</td></tr>
<tr><td rowspan="8">PTA</td><td>Coagulant – Aluminum Sulfate</td><td>8 kg/h</td><td>Villeta to ATOME</td><td>Truck</td><td>30</td></tr>
<tr><td>Flocculant anionic polyamide</td><td>1.3 kg/h</td><td>Villeta to ATOME</td><td>Truck</td><td>30</td></tr>
<tr><td>Sodium hydroxide</td><td>0.3 kg/h</td><td>Villeta to ATOME</td><td>Truck</td><td>30</td></tr>
<tr><td>Sodium hypochlorite</td><td>2.3 kg/h</td><td>Villeta to ATOME</td><td>Truck</td><td>30</td></tr>
<tr><td>Hydrochloric acid</td><td>0.7 kg/h</td><td>Villeta to ATOME</td><td>Truck</td><td>30</td></tr>
<tr><td>Polyelectrolyte</td><td>7.5 kg/h</td><td>Villeta to ATOME</td><td>Truck</td><td>30</td></tr>
<tr><td>Antifouling</td><td>0.19 kg/h</td><td>Villeta to ATOME</td><td>Truck</td><td>30</td></tr>
<tr><td>Sodium bisulfite</td><td>0.94 kg/h</td><td>Villeta to ATOME</td><td>Truck</td><td>30</td></tr>
<tr><td>H2 Plant</td><td>KOH (30% w/w)</td><td>2500 kg/year</td><td>Villeta to ATOME</td><td>Truck</td><td>30</td></tr>
<tr><td rowspan="2">NH3 Plant</td><td rowspan="2">AmoMax © catalyst. Zinc sulfide used as a proxy.</td><td rowspan="2">275313 kg</td><td>Guangzhou to Shenzen, Itapoa to Viletta</td><td>Barge (river)</td><td>1236</td></tr>
<tr><td>Shenzen to Itapoa Port</td><td>Vessel (maritime)</td><td>19,000</td></tr>
<tr><td rowspan="3">AN & SNA Plant</td><td rowspan="2">Vanadium pentoxide</td><td rowspan="2">1.57 kg/day</td><td>Prague to Amsterdam, Itapo Port to ATOME</td><td>Barge (river)</td><td>2,000</td></tr>
<tr><td>Amsterdam to Itapoa Port</td><td>Vessel (maritime)</td><td>11,000</td></tr>
<tr><td>Platinum Rhodium Base - Pt 29.63 kg</td><td>0.1482 kg/day</td><td>Prague to Amsterdam, Itapo Port to ATOME</td><td>Barge (river)</td><td>2,000</td></tr>
</table>
</td><td>
<u>Raw materials and inputs for the operation</u>
<u>GHG emissions associated with the transport of raw materials and inputs.</u>
$$E = EF \times AD$$
Where:
E = GHG emissions, kg CO2-eq/year
EF = Emission factor, kg CO2-eq/kg
AD = Activity data, kg/year

<u>Raw materials for the production of CAN (limestone/dolomite)</u>
<u>GHG emissions associated with the transport of raw materials.</u>
$$Emissions = \sum (Fuel_{ij} \cdot EF_{ij})$$
Where:
Emissions = GHG emissions (kg)
$Fuel_{i,j}$ = Fuel Consumed (TJ)
$EF_{i,j}$ = Emission factor (kg/TJ)
i = Type of vehicle/machinery
j = Fuel type

<u>Calculation of the estimated fuel for the transport of raw materials.</u>
$$Estimated\ fuel = \sum_{i,j,t} [Vehicle_{i,j,t} \cdot Distance_{i,j,t} \cdot Consumption_{i,j,t}]$$
Where:
</td><td>
<u>Raw materials and supplies for operation</u>
a) WWTP & WWTP 1.08 t CO2-eq/year
b) H2 plant 0.013 t CO2-eq/year
c) NH3 plant 12.81 t CO2-eq/year
d) AN & SNA plant 0.015 t CO2-eq/year
e) CAN plant 9.53 t CO2-eq/year

<u>Raw materials for the production of CAN (limestone/dolomite)</u>
a) Fluvial:
Estimated fuel = 280,000 L/year
Fuel = 10.04 TJ/year
Emissions:
• CO2 = 744.02 t/year
• CH4 = 0 t/year
• N2O = 0 t/year
E = 744.02 t CO2-eq/year

b) Terrestrial:
Estimated fuel = 10,950 L/year
Fuel = 0.39 TJ/year [XXV]
Emissions:
• CO2 = 28.89 t/year
• CH4 = 3.7e-03 t/year
</td><td>IPCC (Intergovernmental Panel on Climate Change) Guidelines for National Greenhouse Gas Inventories, 2006. Volume 2 – Energy: Mobile Combustion.</td></tr>
</table>

[XXV] 35.86 MJ/L

Source of Emission		Description	Methodology	Emissions	Reference

			Amsterdam to Itapoa Port	Vessel (maritime)	11,000
	Platinum and rhodium base - Rh 1.56 kg	0.078 kg/day	Prague to Amsterdam, Itapo Port to ATOME	Barge (river)	2,000
			Amsterdam to Itapoa Port	Vessel (maritime)	11,000
	Platinum Rhodium Base - Pd 13.92	0.0696	Prague to Amsterdam, Itapo Port to ATOME	Barge (river)	2,000
			Amsterdam to Itapoa Port	Vessel (maritime)	11,000
CAN Plant	Solid Granulating Agent	201.5 kg/h	Villeta to ATOME	Truck	30
	Liquid Glazing Agent - Siloxane	102.2 kg/h	Villeta to ATOME	Truck	30
	Liquid Coating Agent: Amine	40.8 kg/h	Villeta to ATOME	Truck	30

The activity data calculated by site are as follows:

a) WWTP & WWTP: 6246 t-km
b) H2 plant: 75 t-km
c) NH3 plant: 1,046,187.4 t-km by ship and 68,057.37 t-km by barge
d) AN and SNA plant: 885 t-km by vessel and 161 t-km by barge
e) CAN plant: 54,995 t-km by truck

<u>Raw materials for CAN production: Addition of limestone/dolomite</u>

The methodology used is to initially calculate the annual fuel consumption required for the transport of raw materials. Subsequently, this value is applied together with a diesel vehicle (*FE)* emission factor to calculate the emissions being as follows:

- *EFCO2* = 74,100 kg/TJ
- *EFCH4* = 9.5 kg/TJ
- *EFN2O* = 12 kg/TJ

Additional assumptions for fuel consumption estimation:

- For CAN production, 150 tons of rock per day will be used (based on a 22-hour operating day), totaling approximately 54,750 tons per year
- Logistics involves transport by river from a port in Vallemi, Concepción to a port in Villeta, and then land transport from the port of Villeta to the ATOME plant:

a) River: The transport will be carried out from Vallemi, Concepción, to a port near the Villeta plant, with an extension of 550 km. The type of transport used on this stretch of the river consists of 4x4 convoy tugs with barges, each with a capacity of 1500 tons. In a single trip, it is possible to transport 24,000 tons. The assumed transport efficiency is 245.2 ton-km/L[XXIV]. The emission factor for river transport is *EFCO2* = 74,000 kg/TJ.

b) Road: Transport will be carried out from the port of Terport in Villeta to the ATOME plant, covering a distance of 15 km one way and another 15 km back, resulting in each truck travelling 30 km per day. The truck has a capacity of 35 tons of diesel rock, so 5 trucks will

Estimated fuel = Total fuel consumption estimated from distance traveled (KRV) data
Vehicle,j,t = Number of type *i* vehicles using type *j* fuel on the road type *t*.
Distancei,j,t = Annual kilometres travelled by type *i* vehicle using type *j* fuel on type t road (km)
Consumptioni,j,t = Average fuel consumption (L/km) per type *i* vehicle using type *j* fuel on type *t highway*
i = Type of vehicle (e.g., car, bus).
j = Fuel type (e.g. motor gasoline, diesel, natural gas, LPG)
t = Type of road (e.g., urban, rural).

- N2O = 4.68e-03 t/year

E = 28.89*(1) + 3.7e-03*(28) + 4.68e-03*(296) = 30.37 t CO2-eq/year

[XXIV] NATIONAL WATERWAYS FOUNDATION (2017) A modal comparison of domestic freight transportation effects on the general public: 2001–2014 nationalwaterwaysfoundation.org

<table>
<tr><th colspan="2">Source of Emission</th><th>Description</th><th>Methodology</th><th>Emissions</th><th>Reference</th></tr>
<tr><td></td><td></td><td>be needed for daily production. The annual distance is 15 km* (365 days) = 5475 km per vehicle. The average fuel consumption of the vehicle is 40 litres per 100 km.</td><td></td><td></td><td></td></tr>
<tr><td>Downstream activities: These are indirect greenhouse gas emissions related to goods and services sold.</td><td>CO2 and N2O emissions from managed soils. Application of Calcium Ammonium Nitrate (CAN) in Agriculture</td><td>
<u>Direct emissions:</u> In most soils, an increase in available nitrogen (N) improves nitrification and denitrification rates, which in turn increases nitrous oxide (N2O) production. Increases in available N may be the result of human-induced N additions or changes in land use and/or management practices that mineralize organic N from the soil. The following data are used for the calculation:

FSN = 250,000 t CAN/year * 0.27 t N/t CAN = 67,500 t N/year
EF1 = 0.01 kg N2O-N/kg N

<table>
<tr><th colspan="3">CUADRO 11.1
FACTORES DE EMISIÓN POR DEFECTO PARA ESTIMAR LAS EMISIONES DIRECTAS DE N_2O DE LOS SUELOS GESTIONADOS</th></tr>
<tr><th>Factor de emisión</th><th>Valor por defecto</th><th>Rango de incertidumbre</th></tr>
<tr><td>EF_1 para aportes de N de fertilizantes minerales, abonos orgánicos y residuos agrícolas, y N mineralizado de suelos minerales a causa de pérdida de carbono del suelo [kg N_2O–N $(kg\ N)^{-1}$]</td><td>0,01</td><td>0,003 - 0,03</td></tr>
<tr><td>EF_{1FR} para arrozales inundados [kg N_2O–N $(kg\ N)^{-1}$]</td><td>0,003</td><td>0,000 - 0,006</td></tr>
<tr><td>$EF_{2\,CG,\,Temp}$ para suelos orgánicos templados de cultivo y con pastizales (kg N_2O–N $há^{-1}$)</td><td>8</td><td>2 - 24</td></tr>
<tr><td>$EF_{2\,CG,\,Trop}$ para suelos orgánicos tropicales de cultivo y pastizales (kg N_2O–N $há^{-1}$)</td><td>16</td><td>5 - 48</td></tr>
<tr><td>$EF_{2F,\,Temp,\,Org,\,R}$ para suelos forestales templados y boreales ricos en nutrientes orgánicos (kg N_2O–N $há^{-1}$)</td><td>0,6</td><td>0,16 - 2,4</td></tr>
<tr><td>$EF_{2F,\,Temp,\,Org,\,P}$ para suelos forestales templados y boreales pobres en nutrientes orgánicos (kg N_2O–N $há^{-1}$)</td><td>0,1</td><td>0,02 - 0,3</td></tr>
<tr><td>$EF_{2F,\,Trop}$ para suelos forestales orgánicos tropicales (kg N_2O–N $há^{-1}$)</td><td>8</td><td>0 - 24</td></tr>
<tr><td>$EF_{3PRP,\,CPP}$ para vacunos (lecheros y no lecheros, y búfalos), aves de corral y porcinos [kg N_2O–N $(kg\ N)^{-1}$]</td><td>0,02</td><td>0,007 - 0,06</td></tr>
<tr><td>$EF_{3PRP,\,SO}$ para ovinos y «otros animales» [kg N_2O–N $(kg\ N)^{-1}$]</td><td>0,01</td><td>0,003 - 0,03</td></tr>
<tr><td colspan="3">Fuentes:
EF_1: Bouwman et al. 2002a,b; Stehfest & Bouwman, 2006; Novoa & Tejeda, 2006 en prensa; EF_{1FR}: Akiyama et al., 2005; $EF_{2CG,\,Temp}$, $EF_{2CG,\,Trop}$, $EF_{2F,\,Trop}$: Klemedtsson et al., 1999, IPCC Good Practice Guidance, 2000; $EF_{2F,\,Temp}$: Alm et al., 1999; Laine et al., 1996; Martikainen et al., 1995; Minkkinen et al., 2002; Regina et al., 1996; Klemedtsson et al., 2002; $EF_{3\,CPP}$, $EF_{3\,SO}$: de Klein, 2004</td></tr>
</table>
<u>Indirect emissions:</u> The volatilization of nitrogen compounds and their deposition in soils and water bodies, along with leaching and runoff from fertilizers and agricultural residues, are two main pathways for nitrogen loss in the environment. These nitrogen losses contribute to the emission of nitrous oxide (N2O), which is formed through nitrification and denitrification in groundwater and water bodies. The following data are used for the calculation:

FSN = 250,000 t CAN/year * 0.27 t N/t CAN = 67,500 t N/year
FracGASF = 0.10 (kg NH3–N + NOx–N) (kg N added)$^{-1}$
EF4 = 0.010 kg N2O–N (kg NH3–N + volatilized NOx–N)$^{-1}$
FracLIXIV = 0.3 kg N (kg of nitrogen added or deposited by grazing animals)$^{-1}$
EF5 = 0.0075 kg N2O–N (kg nitrogen leaching/runoff)$^{-1}$

</td><td>
<u>Direct emissions, t N/year</u>
$$N_2O - N_{contributions} = F_{SN} \cdot EF_1$$
Where:
FSN = Annual amount of nitrogen applied to soils in the form of synthetic fertilizer, t/year
EF1 = Amount of N2O emitted by various applications of synthetic and organic N to soils, including agricultural residues and soil organic carbon mineralization in mineral soils due to changes in land use or management, kg N2O-N (kg N)$^{-1}$
<u>Direct emissions, t N2O/year:</u>
$$N_2O_{contributions} = N_2O - N_{contributions} \cdot 44/28$$
<u>Direct emissions, t N/year – Volatilization, N2O (ATD)</u>
$$N_2O_{(ATD)} - N = F_{SN} \cdot Frac_{GASF} \cdot EF_4$$
FSN = Annual amount of nitrogen applied to soils in the form of synthetic fertilizer, t/year
FracGASF = Fraction of nitrogen from synthetic fertilizers that volatilizes as NH3 and NOx, kg N volatilized (kg N added)$^{-1}$
EF4 = Emission factor for N2O emissions from atmospheric deposition of N in soils and water surfaces, kg N–N2O (kg NH3–N + volatilized NOx–N)$^{-1}$
<u>Emissions, t N2O/year:</u>
$$N_2O_{(ATD)} = N_2O_{(ATD)} - N \cdot 44/28$$
<u>Indirect emissions, t N/year – Leaching/Runoff, N2O(L)</u>
$$N_2O_{(L)} - N = F_{SN} \cdot Frac_{LIXIV} \cdot EF_5$$
FSN = Annual amount of nitrogen applied to soils in the form of synthetic fertilizer, t N/year
FracLIXIV = Total N fraction aggregated in managed soils in regions where leaching/runoff occurs, kg N (kg N added)$^{-1}$
EF5 = Emission factor for N2O emissions from N leaching and runoff, kg N2O–N (kg N from leaching and runoff)$^{-1}$
<u>Emissions, t N2O/year:</u>
$$N_2O_{(LIXIV)} = N_2O_{(LIXIV)} - N \cdot 44/28$$
</td><td>
<u>Direct emissions:</u>
N2Ocontributions = 1060.7 t N2O/year

<u>Indirect emissions:</u>
N2O$_{(ATD)}$ = 106.07 t N2O/year
N2O$_{(LIXIV)}$ = 238.66 t N2O/year

<u>Annual CO2-eq emissions:</u>
416,007 t CO2-eq/year
</td><td>IPCC (Intergovernmental Panel on Climate Change) Guidelines for National Greenhouse Gas Inventories, 2006. Volume 4 – Agriculture, forestry and other land uses: N2O emissions from managed soils and CO2 emissions from lime and urea application.</td></tr>
</table>

<table>
<tr><th colspan="2">Source of Emission</th><th>Description</th><th>Methodology</th><th>Emissions</th><th>Reference</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><th colspan="3">CUADRO 11.3
FACTORES DE EMISIÓN, VOLATILIZACIÓN Y LIXIVIACIÓN POR DEFECTO PARA EMISIONES INDIRECTAS DE N_2O DEL SUELO</th></tr>
<tr><th>Factor</th><th>Valor por defecto</th><th>Rango de incertidumbre</th></tr>
<tr><td>EF_4 [volatilización y re-deposición de N], kg N_2O–N (kg NH_3–N + NO_X–N volatilizado)$^{-1}$ [19]</td><td>0,010</td><td>0,002 - 0,05</td></tr>
<tr><td>EF_5 [lixiviación/escurrimiento], kg N_2O–N (kg N lixiviación/escurrimiento)$^{-1}$ [20]</td><td>0,0075</td><td>0,0005 - 0,025</td></tr>
<tr><td>$Frac_{GASF}$ [Volatilización de fertilizante sintético], (kg NH_3–N + NO_x–N) (kg N aplicado)$^{-1}$</td><td>0,10</td><td>0,03 - 0,3</td></tr>
<tr><td>$Frac_{GASM}$ [Volatilización de todos los fertilizantes de N orgánicos aplicados, y de estiércol y orina depositados por animales en pastoreo], (kg NH_3–N + NO_x–N) (kg N aplicado o depositado)$^{-1}$</td><td>0,20</td><td>0,05 - 0,5</td></tr>
<tr><td>$Frac_{LIXIVIACIÓN-(H)}$ [pérdidas de N por lixiviación/escurrimiento en regiones donde Σ(lluvia en la estación lluviosa) - Σ (EP en el mismo período) > capacidad de retención del agua del suelo, O donde se emplea irrigación (excepto por goteo)], kg N (kg N agregado o por deposición de animales en pastoreo)$^{-1}$</td><td>0,30</td><td>0,1 - 0,8</td></tr>
</table>
</td><td></td><td></td><td></td></tr>
<tr><td></td><td>CO2 removal through agricultural activity (crop growth)</td><td>The use of fertilizers improves crop productivity, which can promote the uptake or sequestration of CO2 by plants. This could lead to a reduction in the area of land needed for cultivation [XXVI]. Due to the complexity and scope of the IPCC Guidelines, a rough estimate is used for this source of removal. The study is delimited considering two types of crops, sugarcane and soybeans, due to their higher national and regional production (mainly in Brazil).[XXVII] A CO2 removal factor is estimated for these crops of:
• 0.02 g CO2/m2-day for soybean cultivation[XXVIII], and
• 0.66 t CO2/ha-year for sugarcane cultivation[XXIX]
Soybean crop yields are estimated at around 4,000 kg of soybeans/ha used 320 kg of nitrogen fertilizers[XXX]. Studies indicate a 25% increase in sugarcane yield with the use of nitrogen fertilizers at a rate of 150 kg N/ha[XXXI]. With this data, CO2 removal factors are calculated based on the amount of nitrogen that will be used as fertilizer.
• $EFsoybean = \frac{0.02\ g\ CO2}{m^2-day} \times \frac{1\ t\ CO2}{10^6\ g\ CO2} \times \frac{1\ m^2}{0.001\ ha} \times 150\ días^{XXXII} \times \frac{ha}{320\ kg\ N} = 9.375 \times 10^{-6} \frac{t\ CO2}{kg\ N}$</td><td><u>Elimination of greenhouse gases associated with crop growth activity:</u>
$$R = -EF \times AD$$
Where:
R = GHG emissions, t CO2/year
EF = Emission factor, t CO2 /kg N
AD = Activity data, kg N/year</td><td>R = - 632.8 t CO2 (soybean crops)
E = - 371,250 t CO2 (sugarcane crops)</td><td>2006 IPCC guidelines for national greenhouse gas inventories. Volume 1 - General Guidance and Reporting</td></tr>
</table>

[XXVI] A plant yield of 8 Mg/ha is achieved with the use of 170 kg N/ha, capable of absorbing 12,800 kg CO2/ha, which is equivalent to 75 kg CO2 per kg of N used, e.g. -75 kg CO2-eq/kg N.

[XXVII] FAOSTAT

[XXVIII] Research shows cultivating wheat absorbs more carbon dioxide than it releases - Portal Embrapa

[XXIX] Parr, Jeffrey & Sullivan, Leigh. (2007). Sugarcane the champion crop at carbon sequestration. Jeffrey Parr.

[XXX] Soybeans: Criteria for Crop Fertilization (unc.edu.ar)

[XXXI] Boschiero, B.N., Mariano, E., Torres-Dorante, L.O. et al. Nitrogen fertilizer effects on sugarcane growth, nutritional status, and productivity in tropical acid soils. Nutr Cycl Agroecosyst 117, 367–382 (2020). https://doi.org/10.1007/s10705-020-10074-w

[XXXII] Approximate duration of soybean crops

<table>
<tr><th colspan="2">Source of Emission</th><th>Description</th><th>Methodology</th><th>Emissions</th><th>Reference</th></tr>
<tr><td></td><td></td><td>• $EF sugar\ cane = \frac{0.66\ t\ CO2}{ha-year} \times \frac{ha}{150\ kg\ N} \times 1.25\ years^{XXXIII} = 5.5 \times 10^{-3} \frac{t\ CO2}{kg\ N}$

With an annual production of 250,000 tons of calcium ammonium nitrate (CAN), a nitrogen composition of 27% is estimated. The activity data to be used is:
• AD = 67,500 t N/year * (1000 kg/t) = 67.5e06 kg N /year</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Road transport and distribution of NH3 and CAN</td><td>The mobile fuel consumption method is used, for which the CO2, CH4 and N2O emissions of vehicles used for the transport and distribution of products are estimated. Emissions from the use of fuel from mobile sources are related by type and quantity of fuel or by type of vehicle and total kilometres driven if fuel data are not available.
The emission factors used are as follows:[6]
<table>
<tr><th>Vehicle Type</th><th>CO₂ Factor (kg / unit)</th><th>CH₄ Factor (g / unit)</th><th>N₂O Factor (g / unit)</th><th>Units</th></tr>
<tr><td>Medium- and Heavy-Duty Truck</td><td>1,387</td><td>0,013</td><td>0,038</td><td>vehicle-mile</td></tr>
<tr><td>Passenger Car [A]</td><td>0,313</td><td>0,008</td><td>0,007</td><td>vehicle-mile</td></tr>
<tr><td>Light-Duty Truck [B]</td><td>0,467</td><td>0,013</td><td>0,012</td><td>vehicle-mile</td></tr>
<tr><td>Medium- and Heavy-Duty Truck[C]</td><td>0,170</td><td>0,0016</td><td>0,0047</td><td>ton-mile</td></tr>
<tr><td>Rail</td><td>0,021</td><td>0,0016</td><td>0,0005</td><td>ton-mile</td></tr>
<tr><td>Waterborne Craft</td><td>0,044</td><td>0,0254</td><td>0,0011</td><td>ton-mile</td></tr>
<tr><td>Aircraft</td><td>0,698</td><td>0</td><td>0,0215</td><td>ton-mile</td></tr>
</table>
Converting to kilometers, the factors to use are as follows:
• EFCO2 = 0.1056 kg CO2/t-km
• EFCH4 = 9.94e-07 kg CH4/t-km
• EFN2O = 2.92e-06 kg N2O/t-km
Two study frameworks are distinguished, each with its possible scenarios:
1. NH3 Production:
a) Land transport of green ammonia from the Plant to the Villeta Industrial Zone for the production of ammonia-based fertilizers, 30 km.
b) Land transport of grey ammonia from the Port of Villeta to the Villeta Industrial Zone for the production of ammonia-based fertilisers, 15 km.
2. CAN Production:
a) Road transport of green CAN from the Plant to the ports of Villeta for export, 25 km.
b) Green CAN road transport from the Plant to the final destinations in Brazil:
i. 1488 km Villeta – São Paulo,
ii. 1778 km Villeta – Miras Gerais,
iii. 1200 km Villeta – Rio Grande do Sul.</td><td>Total annual emissions from the transport and distribution of the final product
$$Emissions = \sum_a [Product \cdot Distance \cdot EF_a]$$
Where:
Emissions = GHG emissions, kg/year
Product = Quantity of product transported annually, t/year
Distance = Distance traveled per trip, km
EFa = Emission factor, kg GHG/t-km.
a = GHG type (e.g. CO2, CH4, N2O)</td><td>Ammonia production, 100,000 t/year
Scenario (a):
Emissions = 316.8 t CO2/year*(1) + 6.21e-03 t CH4/year*(28) + 0.0182 t N2O/year*(296) = 322.36 t CO2-eq/year

Scenario (b):
Emissions =159.74 t CO2-eq/year

CAN production, 250,000 t/year
Scenario (a):
Emissions = 660 t CO2/year*(1) + 2.98e-03 t CH4/year*(28) + 8.76e-03t N2O/year*(296) = 662.67 t CO2-eq/year
Scenario (b):
i. Emissions = 39,284.65 t CO2-eq/year
ii. Emissions = 47,335.76 t CO2-eq/year
iii. Emissions = 31,947.64 t CO2-eq/year</td><td>GHG Emission Factors Hub | US EPA

GHG Protocol. Technical Guidance for Calculating Scope 3 Emissions Supplement to the Corporate Value Chain (Scope 3) Accounting & Reporting Standard</td></tr>
<tr><td></td><td>River and sea transport and</td><td>The methodology covers maritime and river transport, ranging from recreational activities to large cargo ships powered primarily by low-, medium- and high-speed diesel engines, as well as steam or gas turbines. Maritime and river transport generates emissions of CO2, CH4 and N2O, as well as CO, volatile organic compounds other than methane (VOCs), SO2, particulate matter</td><td>Equation for Maritime and Inland Waterway Navigation
$$ECO2_a = AD \cdot EF_a \cdot D \cdot 10^{-6}$$
Where:
ECO2 = CO2 emissions by type of transport, t CO2/year</td><td>Ammonia, AD = 100,000 t/year
Scenario 1 & 2: Transport of NH3 from the Port of Rotterdam to the Port of Villeta</td><td>IPCC (Intergovernmental Panel on Climate Change)</td></tr>
</table>

XXXIII Approximate Duration of Sugarcane Crops from Planting to Harvest Stages of Sugarcane Cultivation | Ministry of Agriculture and Rural Development | Government | gob.mx (www.gob.mx)

Source of Emission		Description	Methodology	Emissions	Reference
	distribution of NH3 and CAN	(PM) and NOx. The following study frameworks are distinguished, along with their possible scenarios: Ammonia Production: Scenarios: 1. Sea route: Transport from the Port of Rotterdam to the Port of Nueva Palmira, Uruguay, 14,500 km. 2. River route: Transport from Nueva Palmira, Uruguay, to the Port of Villeta, 1,593 km. CAN Production: Scenarios: 1. River route: Transport from Puertos de Villeta to the Port of Nueva Palmira, Uruguay, 1,593 km. 2. Sea route: Transport from the Port of Nueva Palmira to the Port of Santos, São Paulo, Brazil, 1,800 km. 3. Sea route: Transport from the Port of Rotterdam to the Port of Santos, São Paulo, Brazil, 24,550 km The emission factors to be used are related in terms of CO2 emissions per tonne of cargo transported per kilometre, using the following values for the calculation:[7] • Ocean freight, *EF* = 3 g CO2/t-km • River transport, *EF* = 7.9 g CO2/t-km	*EF* = emission factor per type of transport a, g CO2/t-km *D* = Distance travelled per trip, km *AD* = Activity data, in this case, the quantity of product to be transported annually, t/year a = Type of transport, river or sea	• *ECO2* = 4350 + 1258.5 = 5608.5 t CO2/year CAN, *AD* = 250,000 t/year Scenario 1 and 2: Transport of the CAN from Villeta to the Port of Santos, SP-BR • *ECO2* = 4496.17 t CO2/year Scenario 3: Transport of the CAN from the Port of Rotterdam to the Port of Santos, SP-BR • *ECO2* = 18,412.5 t CO2/year	Guidelines for National Greenhouse Gas Inventories, 2006. Volume 2 – Energy: Mobile Combustion.
	Wastewater treatment and disposal	The most widespread wastewater treatment methods in developed countries are centralized facilities for aerobic wastewater treatment and lagoons for domestic and industrial wastewater. In nitrogen fertilizer plants, the wastewater generated contains ammonia nitrogen (NH3-N and NH4+-N), nitrates (NO_3^--N), and organic nitrogen (Org-N). Under normal production conditions, organic nitrogen is not expected to be found in wastewater from ammonium nitrate plants. Direct emissions resulting from nitrification and denitrification in wastewater treatment facilities can be considered minor sources. [1] Continuous emissions to water can be up to 5,000 mg AN-N per liter and 2,500 mg NH3-N/L (equivalent to 6 and 3 kg/t of product, respectively). Applying best available techniques (BAT) would result in 100 mg N/L (0.2 kg N/t AN) The IPCC 2019 introduces new methodologies and values for effluents generated by industries. These are the characteristic values of the effluents generated by the nitrogen fertilizer industry: • $_j$ = secondary (biological) effluent treatment system and discharge to aquatic systems • *Pi* = 250,000 t CAN/year • *Wi* = 2.89 m3/t (2.66 m3/t for ATOME plant)[XXXIV] • *TNi* = 0.5 kg N/m3 • *Tj* = 0% as the treatment plant will be operating continuously	Total Nitrogen in Industrial Effluents $TN_{IND_i} = P_i \cdot W_i \cdot TN_i$ *TNINDi* = Total nitrogen in the influent entering industrial treatment, kg N/year. i = Industrial sector *Pi* = Annual production of industry i, t/year. *Wi* = Effluent generated by industry i, m3/tonne of product. *TNi* = Total nitrogen in effluent generated by the industrial sector i, kg N/m3 N2O emissions from industrial effluent treatment plants $N2O\ Plants_{IND} = \left[\sum_i \left(T_{i,j} \cdot EF_j \cdot TN_{IND_i}\right)\right] \cdot 44/28$ Where: *N2OPlants,IND* = N2O emissions from industrial effluent treatment plants, kg N2O/year *TNIND,i* = total nitrogen in the influent entering the treatment for the industrial sector i, kg N/year	Total Nitrogen in Industrial Effluents *TNINDi* = 332,500 kg N/year N2O emissions from industrial effluent treatment plants *N2OPlants,IND* = 8,882.5 kg N2O/year Total nitrogen in industrial effluent treated for discharge *NEffluent,IND* = 49,875 kg N/year N2O emissions from the discharge of treated effluents *N2OEffluent,IND* = 391.88 kg N2O/year	IPCC (Intergovernmental Panel on Climate Change) Guidelines for National Greenhouse Gas Inventories, 2019. Volume 5 – Waste: Wastewater treatment and disposal.

[XXXIV] Production of 250,000 tons/year of CAN and generation of 658,976 m3/year of industrial effluents, especially wastewater.

<table>
<tr><th colspan="2">Source of Emission</th><th>Description</th><th>Methodology</th><th>Emissions</th><th>Reference</th></tr>
<tr><td></td><td></td><td>
• NREM,j = 85%
• EFEffluents = 0.005 kg N2O/kg N
• EFj = 0.017 kg N2O/kg N [XXXV]
<table>
<tr><th colspan="5">TABLE 6.12 (NEW)
EXAMPLES OF INDUSTRIAL WASTEWATER DATA</th></tr>
<tr><th>Industry Type</th><th>Wastewater Generation W (m³/tonne)</th><th>Range for W (m³/tonne)</th><th>Total Nitrogen (TN) (kg/m³)</th><th>TN Range (kg/m³)</th></tr>
<tr><td>Alcohol refining</td><td>24[2]</td><td>16 – 32[2]</td><td>2.4[2]</td><td>0.94 – 3.86[2]</td></tr>
<tr><td>Beer & malt</td><td>6.3[2]</td><td>5.0 – 9.0[2]</td><td>0.055[3]</td><td>0.025 – 0.08[3]</td></tr>
<tr><td>Fish processing</td><td>5[2]</td><td>2 – 8[2]</td><td>0.60[2]</td><td>0.21 – 0.98[2]</td></tr>
<tr><td>Iron and steel manufacturing</td><td>5[1]</td><td>0.004 – 10.4[4]</td><td>0.25[1]</td><td>0.0004 – 0.524[4]</td></tr>
<tr><td>Meat & poultry</td><td>13[2]</td><td>8 – 18[2]</td><td>0.19[2]</td><td>0.17 – 0.20[2]</td></tr>
<tr><td>Nitrogen fertiliser</td><td>2.89[2]</td><td>0.46 – 8.3[2]</td><td>0.5[2]</td><td>0.1 – 0.8[2]</td></tr>
<tr><td>Plastics & resins</td><td>0.6[5]</td><td>0.3 – 1.2[5]</td><td>0.25[6]</td><td>No range provided</td></tr>
<tr><td>Starch production</td><td>9[2]</td><td>4 – 18[2]</td><td>0.9[2]</td><td>0.8 – 1.10[2]</td></tr>
<tr><td colspan="5">[1] Based on expert judgment by Lead Authors of this section.
[2] IPCC (2014)
[3] Simate et al. (2011)
[4] US EPA (2002a)
[5] Doorn et al. (1997)
[6] Li et al. (2016)</td></tr>
</table>
</td><td>
Ti,j = Degree of use of the treatment/discharge system j, for the industrial sector i
i = Industrial sector
j = Type of treatment/discharge system
EFj = Emission factor for treatment/discharge system j, kg N2O/kg N

<u>Total nitrogen in industrial effluent treated for discharge</u>
$$N_{Effluent,IND} = \left[\sum_j TN_{IND_i} \cdot T_j \cdot (1 - N_{REM_i})\right]$$
NEffluent,IND = Total nitrogen content in treated industrial effluent, kg N/year
TNIND,i = Total nitrogen in industrial effluent entering treatment, kg N/year
Tj = Degree of utilization of the treatment/discharge system
j = Type of treatment/discharge system
NREM,j = Fraction of total nitrogen removed during treatment by treatment type j

<u>N2O emissions from the discharge of treated effluents.</u>
$$N_2O\ Effluents_{IND} = N_{Effluent,IND} \cdot EF_{Effluent} \cdot 44/28$$
N2OEffluent,IND = N2O emissions from industrial effluent discharge, kg N2O/year
NEffluent,IND = Total nitrogen content in treated industrial effluent discharged into aquatic systems, kg N/year
EFEffluent = Emission factor for N2O emissions from treated industrial effluents discharged into aquatic systems, kg N2O-N/kg N
</td><td>
<u>Total N2O emissions</u>
Total N2O = 9.27 t N2O/year
Total CO2-eq = 2745.2 t CO2-eq/year
</td><td></td></tr>
<tr><td></td><td>End-of-life treatment of the product sold</td><td>
This category includes emissions from the disposal and treatment of waste from products sold by ATOME at the end of their useful life. Fertilizer itself is a consumer product in crops, so disposal emissions are associated with packaging waste. It was assumed that CAN is packaged in 1000 kg polypropylene bags, commonly known as big bags, and the weight of each bag was estimated. In addition, it was assumed that all packaging waste is recycled by the end consumer. The following data and assumptions are used for the calculation:
• Total mass of products sold: 250,000 t CAN/year
</td><td>
<u>GHGs associated with end-of-life treatment of the product sold (big bag recycling)</u>
$$E = EF \times AD$$
Where:
E = GHG emissions, kg CO2-eq/year
EF = Emission factor, kg CO2-eq/kg
AD = Activity data, kg/year
</td><td>
<u>Emissions from the recycling of polypropylene big bags:</u>
• E = 34.6 t CO2-eq/year
</td><td>GHG Protocol. Technician. Category 12: End-of-life treatment of products sold</td></tr>
</table>

XXXV EFDB - Basic Search (iges.or.jp) Emission Factor for Industrial Wastewater Treatment Facilities: Manufacture of Chemicals and Related Products.

Source of Emission		Description	Methodology	Emissions	Reference
		• Packaging mass used to transport the can from the point of sale to the end of its shelf life after use by the consumer: 0.5 kg/big-bag • Activity data, *AD* = 250,000 t CAN/year * 1 big-bag/ 1 t CAN * 0.5 kg/big-bag = 125,000 kg big bags/year (125 t/year) • Assuming recycling as waste treatment, the average specific emission factor is *EF* = 0.277 kg CO2-eq/kg			Life Cycle Assessment (LCA) Database (Ecoinvent 3, version 3.8) AECOM Document: "ATOME Comparative Product CAN Carbon Footprint Fertilizer"

References

[1] Intergovernmental Panel on Climate Change, IPCC Guidelines for National Greenhouse Gas Inventories, 2006.

[2] GHG Protocol (WRI and WBCSD), Greenhouse Gas Protocol.

[3] Intergovernmental Panel on Climate Change, 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, 2019.

[4] S. Wood and A. Cowie, "A Review of Greenhouse Gas Emission Factors for Fertiliser Production," 2004.

[5] Best Available Techniques for Pollution Prevention and Control in the European Fertilizer Industry, "Production of ammonium nitrate and calcium ammonium nitrate," 2000.

[6] EPA (Environmental Protection Agency), "Emission Factors for Greenhouse Gas Inventories (last modified 18 April 2023)," 2023.

[7] IMO (International Maritime Organization), "The Fourth IMO GHG Study," 2020.

Annex 13 – Public Consultation Report

ATOME

ATOME PARAGUAY S.A.

Free Trade Zone and Hydrogen, Ammonia and Green Fertilizer Production Plant of ATOME Paraguay S.A.

Report of the Public Consultation

December/2023

JGP

Free Trade Zone and Hydrogen, Ammonia and Green Fertilizer Production Plant of ATOME Paraguay S.A.

Report of the Public Consultation

December/2023

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JGP

1.0
Introduction

This document is the report on the consolidation of the planning, dissemination and execution of the Public Consultation on the Free Trade Zone Project and Hydrogen, Ammonia and Green Fertilizer Production Plant ATOME Paraguay S.A.

The Public Consultation seeks to expose to the public the content of the EsIA developed for the Project, and to open a channel of direct dialogue between Atome and the interested parties and affected by the Project, providing mechanisms to clarify doubts and collect applicable criticisms and suggestions from interested parties.

The aim of this report is therefore to show the actions taken before and on the day of the event.

2.0
Disclosure

As proposed in the Consultation Plan prepared and approved by Atome, various means of dissemination and invitation were used for the Public Consultation, informing of the date, time and place of the event. Activities included radio outreach, transportation and the distribution of invitations.

Radio

The call for Public Consultation was broadcast on radio 5 de Marzo (90.3 FM) from 06 to 13/12/2023. Five (5) daily insertions were made throughout the program.

Car with loudspeaker

A car with a loudspeaker was hired to publicize the Public Consultation, indicating the place, date and time.

The car toured the areas of Villeta, Puerto Lobato (Ypeka'e) and Surubiy in the morning and afternoon between 06 and 13/12/2023. The **Photo Record** in **Exhibit 1** includes a photo of the car with a loudspeaker. Also attached are some videos showing the car in different places and times of the disclosure.

Invitations

Invitations were sent via email and WhatsApp to all stakeholders and affected by the Project listed in the expanded Stakeholder Map, which was submitted as an annex to the Consultation Plan. Among the invited stakeholders were the Mayor of the Municipality of Villeta, the Municipal Board and the Volunteer Firefighters of the
city of Villeta, as well as the Ministries of Environment and Sustainable Development (MADES), Industry and Commerce (MIC), Public Works and Communications (MOPC), Labor, Employment and Social Security (MTESS).

Invitations were also sent by email and WhatsApp to the owner of a rice mill located in the AID, to residents of Estancia Lola, also in the AID, to the Ypeka'e Fishermen's Association, to the 49 Surubiy Police Station and to the owners of the affected land and to the neighbors of the land. Some invitations were personally delivered to residents of Villeta, as shown by some photos from the **Photographic Record** in **Annex 1**.

3.0
Transport for Public Consultation

Free transportation was provided to residents of the Ypeka'e community interested in participating in the Public Consultation. A **photo of the bus used in this transport is shown** in the Photographic Record **of** Annex 1.

The vehicle was available at 4:00 p.m. in front of the Ypeka'e police station. He arrived at the Public Consultation site at 5:00 p.m. and returned to the community after the event.

4.0
Public Consultation

The Public Consultation took place in person on December 13, 2023 at 6:00 p.m. in the event room of the River Hotel, located on General Díaz Street, Villeta. Before entering the room, all participants signed the attendance list (see photos in **Annex 1**) and received a brochure with information about the Project. The list of assistance can be found in **Annex 2** and the booklet in **Annex 3**.

Both on arrival and at the end of the event, refreshments were offered to the attendees (see photos in **Annex 1**).

The Photographic Record in **Annex 1** shows photos of the event, including some that show the characteristics of the venue and the structure set up for the Consultation, the participants, the preparation of the minutes, the presenters, the participants asking their questions and the representatives of Atome Paraguay and the environmental consultancy (JGP Consultoria) answering the questions.

The Public Consultation was opened by Viviana Brun, environmental coordinator of Atome Paraguay, who thanked everyone for their presence, explained the dynamics of the meeting, the objectives and the expected results, highlighting that the contributions of those present will be taken into account in the final version of the ESIA. Viviana formed the table with Juan Pablo Nogues, Project Manager of ATOME Paraguay and Bruno Del Grossi Michelotto, geographer and consultant of JGP Consultoria, the company responsible for the preparation of the Environmental and Social Impact Study – ESIA of the project.

The cycle of presentations (see copy of the presentation in **Annex 4**) began with Juan Pablo Nogues, Project Manager of Atome Paraguay, who thanked those present, and continued to present information about the company Atome and details of the Project, including the location and its components, information about hydrogen, ammonia and green fertilizer and their advantages, the main and auxiliary facilities of the Plant, the operation and maintenance aspects and the environmental controls that will be adopted to avoid and minimize impacts.

Next, Juan Pablo introduced Bruno Michelotto, consultant and specialist in physical environment at JGP Consultoria, who participated in the preparation of the ESIA. Bruno began the presentation with the studies of locational and technological alternatives carried out for the Plant, the power transmission line (LT) and the water and effluent pipes, and that the objectives of these studies were to achieve a Project with the best possible technology and to seek the most suitable location for its construction and operation. in order to cause the least possible environmental and social impact.

He also presented succinct information on the baseline made for the areas of indirect and direct influence and the area directly affected by the Project. He explained the studies and data collection on climate, water resources, geology, geomorphology and soils, environmental noise and air quality, flora and fauna, and socioeconomic data of the municipality of Villeta and the area surrounding the Plant land, through the investigation of secondary data in official sources and fieldwork with surveys and interviews.

Bruno then explained the methodology used to identify and evaluate the environmental and social impacts of the Project and the main impacts and risks evaluated for the Project in its construction and operation phases, highlighting that the main ones will be of low magnitude due to the technology adopted for the Plant and the environmental controls that will be applied by the operation and maintenance company to be contracted by Atome. He also described the main measures envisaged in the Environmental and Social Management Plan (ESMP) to prevent, mitigate, control and compensate for the impacts and risks identified and evaluated. The ESMP includes a set of 12 Programs, which Bruno briefly presented below, highlighting that the measures established in the Programs will be implemented during the construction and operation of the Project as a commitment by Atome to achieve a Project with minimal environmental and social impacts.

Once the presentation was over, Juan Pablo took the floor again and opened the question and answer session.

In general, the main questions and comments related to the following issues:

- Impacts of the Project on the quantity and quality of water in the Paraguay River
- Impacts of the Project on the fishing activity of the Ypeka'e community
- Cumulative impacts of the project, considering other industries installed and planned in the area of influence
- Risks to the population related to hydrogen and ammonia

The full description of the questions and comments made in the Consultation can be found in the Minutes presented in **Annex 5**.

5.0
Conclusion

Considering the proposal presented in the Consultation Plan, it is considered that the general and specific objectives established for the Public Consultation were met.

All stakeholders were informed in advance about the Project and the Public Consultation, through radio disclosures, car with loudspeakers and invitations sent via email and WhatsApp. The presence of a considerable number of people (55 in total), including the important and active participation of residents of the community of Ypeka'e and representatives of the Councillor of Villeta, among other stakeholders from the Project's area of influence, with numerous statements and questions (18 in total), demonstrates the full scope of the outreach activities of the Public Consultation.

The dialogue channel with Atome was established through the availability of email and WhatsApp, and it is expected that the population will use these channels in the next phases of the Project.

6.0
Technical Team

Responsible Directors:	
Juan Piazza	Managing Partner
Ana Maria Iversson	Sociologist
Coordination:	
Renata Cristina Moretti	
Bruno Del Grossi Michelotto	
JGP Technical Team:	
Ana Paula de Azevedo Lima	Technical support / Coordination of the organisation of the public consultation
Renata Michelle A. Oliveira	Visual programming of outreach material

ANNEXES

Annex 1 – Photographic Record

Photo 1: Car with loudspeaker doing outreach.

Photo 2: Personal handing out invitations to the residents of Villeta.

Photo 3: Personal handing out invitations to the residents of Villeta.

Photo 4: Free bus provided for the transfer of interested parties from Ypeka'e.

Photo 5 and 6: Participants signing a list of attendance at the event.

Photo 7 and 8: Participants signing a list of attendance at the event.

Photo 9 and 10: Refreshments served to participants before and after the Public Consultation.

Photo 11: General view of the room where the Public Consultation was held.

Photo 12: Detail of the exterior available.

Photo 13 and 14: Visión general de la asistencia durante la Consulta Pública.

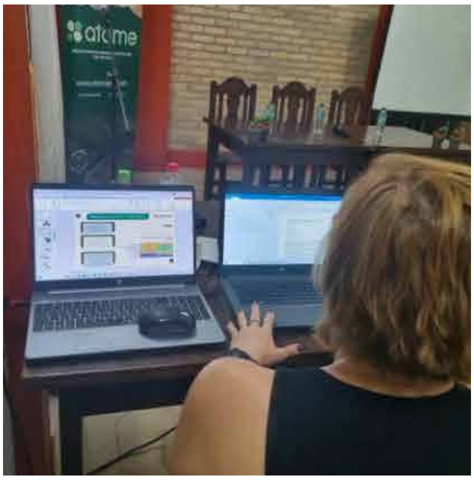


Photo 15: Details of the preparation of the minutes of the Public Consultation

Photo 16: Executive summary of the ESIA available during the event.

Photo 17: Presentation of the project by Juan Pablo Nogués, from ATOME Paraguay.

Photo 18: Presentation of the ESIA by Bruno Michelotto, JGP Consultoria.

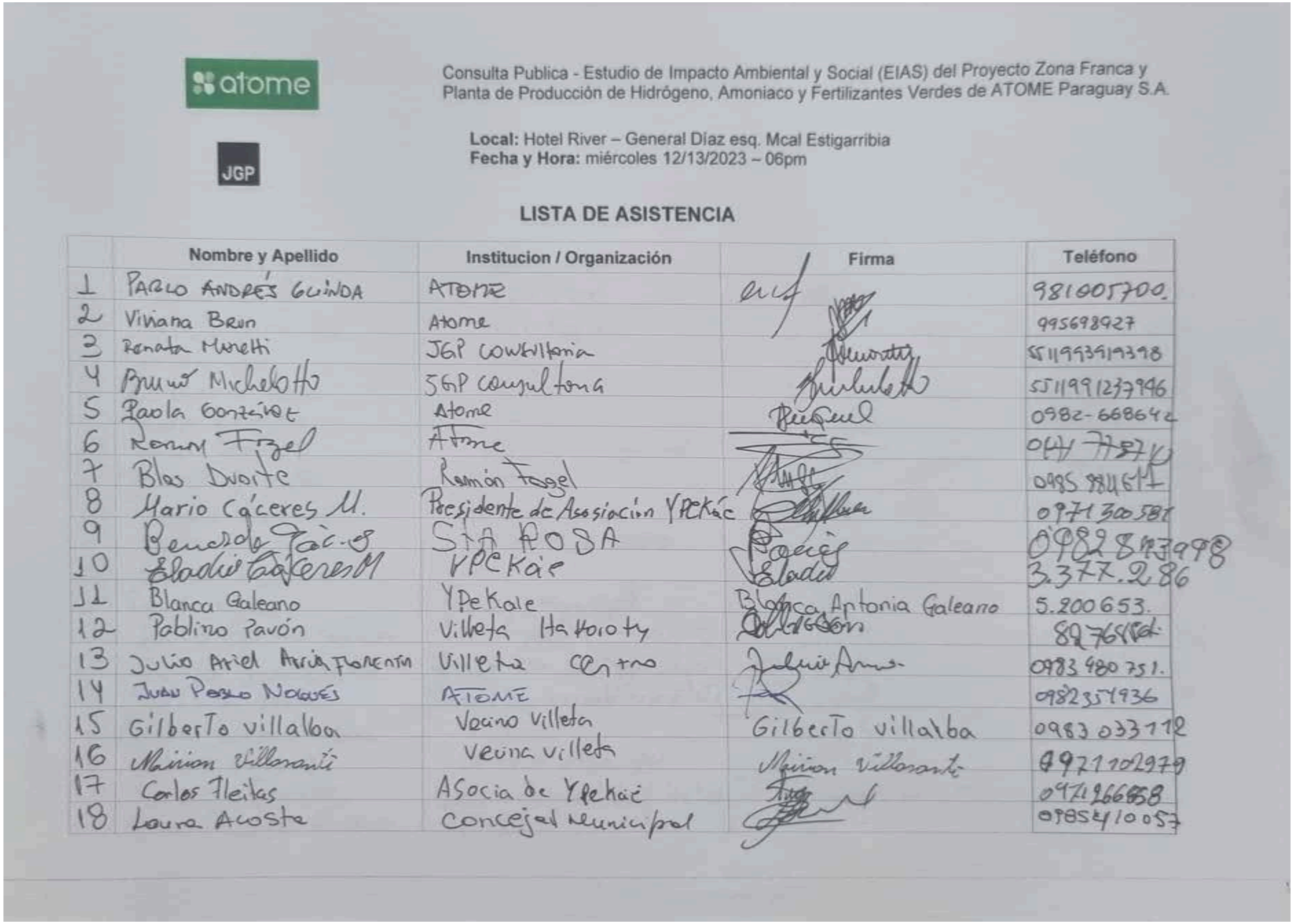
Photo 19 and 20: Participants asking questions orally.

Photo 21 and 22: Participants asking questions orally.

Photo 23 and 24: ATOME and JGP representatives answering questions.

Annex 2 – Attendance List

	Public Consultation – Free Trade Zone and Green Hydrogen, Ammonia and Fertilizer Production Plant	
JGP	PHOTOGRAPHIC RECORDS	ATOME



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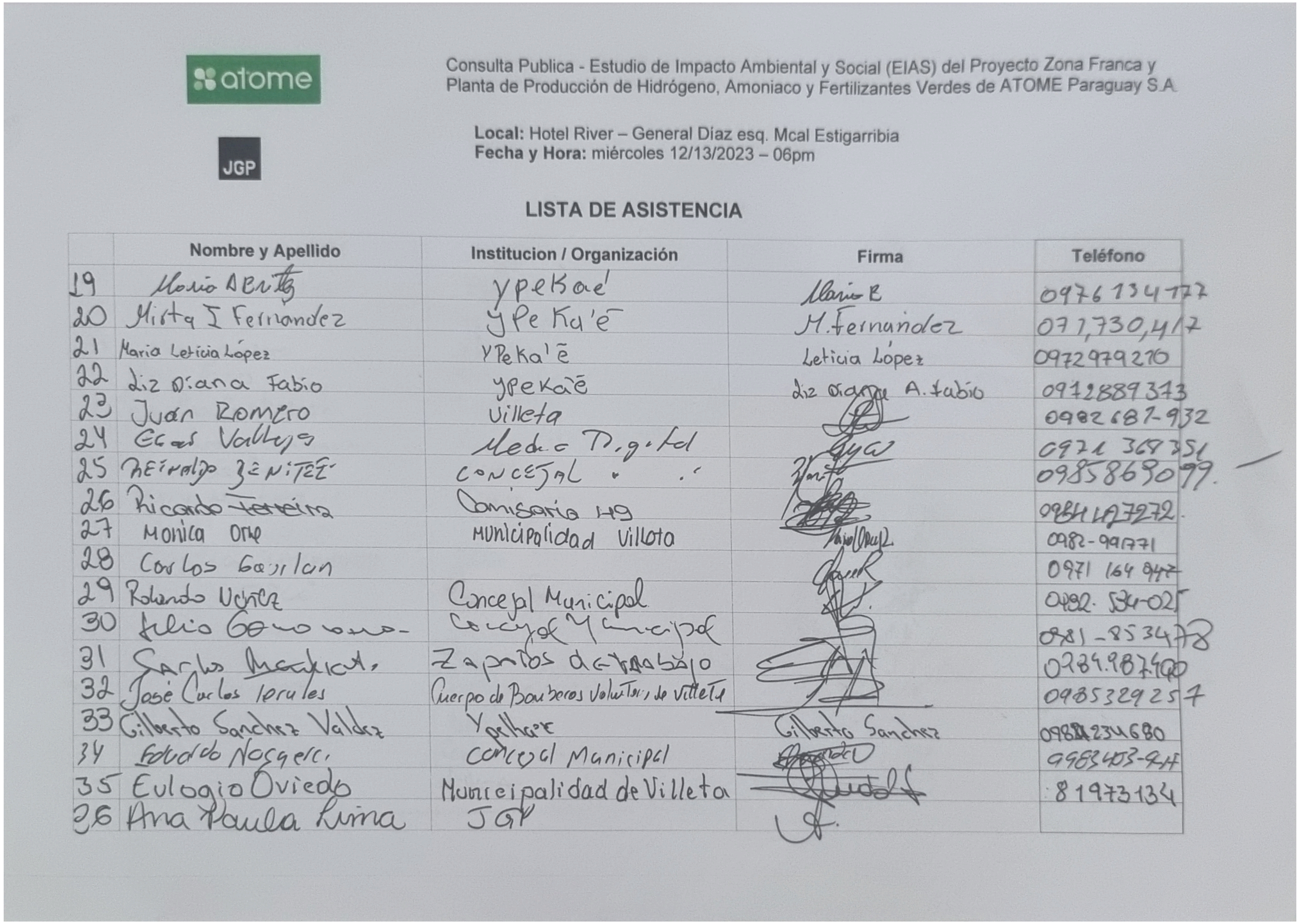
Consulta Publica - Estudio de Impacto Ambiental y Social (EIAS) del Proyecto Zona Franca y Planta de Producción de Hidrógeno, Amoniaco y Fertilizantes Verdes de ATOME Paraguay S.A.

Local: Hotel River – General Díaz esq. Mcal Estigarribia
Fecha y Hora: miércoles 12/13/2023 – 06pm

LISTA DE ASISTENCIA

	Nombre y Apellido	Institucion / Organización	Firma	Teléfono
1	PABLO ANDRÉS GUINDA	ATOME		981005700.
2	Viviana Brun	Atome		995698927
3	Renata Moretti	JGP consultoria		5511993919398
4	Bruno Michelotto	JGP consultoria		5511991237946
5	Paola González	Atome		0982-668642
6	Ramon Fogel	Atome		0[illegible]
7	Blas Duarte	Ramón Fogel		0985 [illegible]
8	Mario Cáceres M.	Presidente de Asosiación Ypekáe		0971 300581
9	Bernardo [illegible]	STA ROSA		0982 8[illegible]998
10	Eladio Cáceres M	YPEKAE		3.377.286
11	Blanca Galeano	Ypekale	Blanca Antonia Galeano	5.200653.
12	Pablino Pavón	Villeta Ha[illegible]		89[illegible]
13	Julio Ariel Arria Florentin	Villeta centro		0983 480 751.
14	JUAN PABLO NOGUÉS	ATOME		0982354936
15	Gilberto villalba	Vecino Villeta	Gilberto villalba	0983 033112
16	Mirion Villasanti	Vecina villeta	Mirion Villasanti	0971102979
17	Carlos Fleitas	Asocia de Ypekaé		0971266858
18	Laura Acosta	concejal Municipal		0985410057

JGP	Public Consultation – Free Trade Zone and Green Hydrogen, Ammonia and Fertilizer Production Plant	ATOME
	PHOTOGRAPHIC RECORDS	



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Consulta Publica - Estudio de Impacto Ambiental y Social (EIAS) del Proyecto Zona Franca y Planta de Producción de Hidrógeno, Amoniaco y Fertilizantes Verdes de ATOME Paraguay S.A

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LISTA DE ASISTENCIA

	Nombre y Apellido	Institucion / Organización	Firma	Teléfono
19	Mario Benitez	Ypekaé	Mario B	0976134177
20	Mirta I Fernandez	Ype Ka'ẽ	M.Fernandez	071,730,417
21	Maria Leticia López	Ypeka'ẽ	Leticia López	0972979210
22	Liz Diana Fabio	Ypekaẽ	Liz Diana A. Fabio	0972889373
23	Juan Romero	Villeta		0982687-932
24	[illegible] Vallejos	Medio Digital		0971 369 351
25	Reinaldo Benitez	Concejal		0985869077
26	Ricardo Ferreira	Comisaria 49		0984 427272
27	Monica Orue	Municipalidad Villeta		0982-991771
28	Carlos Gavilan			0971 164 947
29	Rolando [illegible]	Concejal Municipal		0982 534-025
30	Julio [illegible]	Concejal Municipal		0981-853478
31	Carlos [illegible]	Zapatos de trabajo		0984.987400
32	José Carlos Morales	Cuerpo de Bomberos Voluntarios de Villeta		0985329257
33	Gilberto Sanchez Valdez	Ypehare	Gilberto Sanchez	0981234680
34	Eduardo Noguera	Concejal Municipal		0983403-924
35	Eulogio Oviedo	Municipalidad de Villeta		81973134
36	Ana Paula Lima	JGP		

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Consulta Publica - Estudio de Impacto Ambiental y Social (EIAS) del Proyecto Zona Franca y Planta de Producción de Hidrógeno, Amoniaco y Fertilizantes Verdes de ATOME Paraguay S.A.

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Fecha y Hora: miércoles 12/13/2023 – 06pm

LISTA DE ASISTENCIA

	Nombre y Apellido	Institucion / Organización	Firma	Teléfono
37	Graciela Cáceres	Ype Kaé	Graciela Cáceres	0972879332
38	Liliana Fernandez	Ype Ka'e	Liliana Fernandez	0972748345
39	Liviana. cantero	Ype ka'e	Liviana cantero.	0971792377
40	José Torres	Municipalidad Villeta		0991637020
41	Carolina Centurión	Ministerio de Industria y Comercio (MIC)		0994-250802
42	Maria Irene Gamarra J	Junta Municipal		0984 110 087.
43	Graciela Rodas	Villeta (Docente)		0984-505269
44	Nery Martinez C.	Villeta vecina		84-529607
45	Javier Jimenez	MADES - CTCA.		0971200836
46	FEDERICO SCHROEDER	DSQ - DCA - MADES		71.916662.
47	Nelson Orué	Concejal municipal		91.685223
48	Fidelina Garcia	Vecina Villeta		1.193.035.
49	Julio C. Garcia.	Cuerpo de Bomberos de Villeta		4.551.520
50	Rosa Cambra	Com pueblana.		0983.286.393
51	JORGE CASTRO	Ciudadano.		0981 558.100
52	Inés Franceschelli	Centro de Estudios Heñói		81 530 444
53	O. Viviana Fogel A.	Villeta		81-676461

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Consulta Publica - Estudio de Impacto Ambiental y Social (EIAS) del Proyecto Zona Franca y Planta de Producción de Hidrógeno, Amoniaco y Fertilizantes Verdes de ATOME Paraguay S.A.

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LISTA DE ASISTENCIA

	Nombre y Apellido	Institucion / Organización	Firma	Teléfono
54	Angel Tuminetti	Heñói Centro de Estudios		982333793
55	Mariela Jazmin Krayacich	Concejal Municipal - JMV		0994882572

Annex 3 – Prospectus

Free Trade Zone and Hydrogen, Ammonia and Green Fertilizer Production Plant of ATOME Paraguay S.A.

December 2023

PRESENTATION

This brochure provides information to the population of the area of influence about the ATOME Hydrogen, Ammonia and Green Fertiliser Production Plant Project.

THE PROJECT

The Project consists of a Hydrogen, Ammonia and Green Fertilizer production plant to be built in the city of Villeta, Paraguay, at km 29 of the Villeta- Alberdi road, near the ANDE's Buey Rodeo substation (SE).

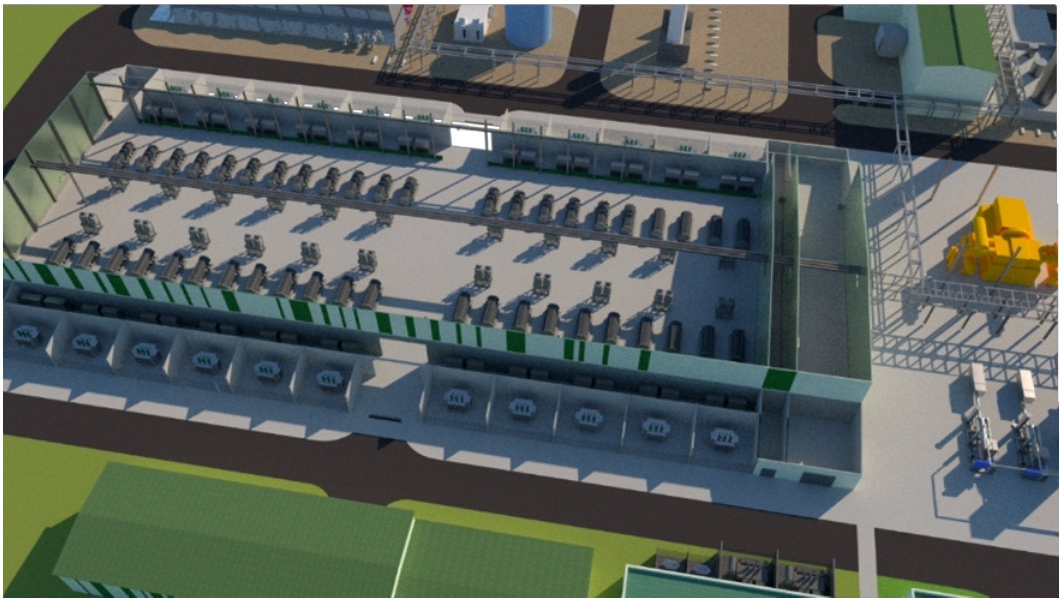
The following components are also part of the project:

- A 220 kV power transmission line (TL) of about 550 m in length.
- Catchment, pumping and piping for water supply from the Paraguay river to the ATOME plant and effluent discharge piping.

The project includes the word green in its name because the production of hydrogen from water will use electricity from a renewable energy source, in this case hydroelectricity (energy produced at the Itaipu power plant).

MAIN PLANT FACILITIES

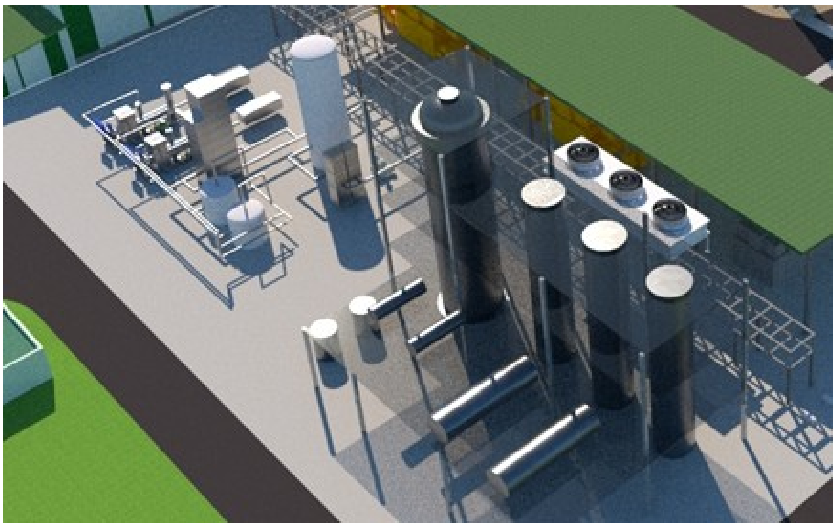
Green Hydrogen Plant (H_2) - Houses electrolysers that produce hydrogen using electrical energy coming from ANDE's Buey Rodeo Substation (SE) through a transmission line (TL). The TL will also be built as part of the project.



View of the hydrogen production plant.

Air Separation Unit - captures air and separates nitrogen from other gases that make up the air. The nitrogen is then used to produce ammonia.

Ammonia Synthesis Unit - houses the reactor where ammonia is produced from the mixture of hydrogen and nitrogen.



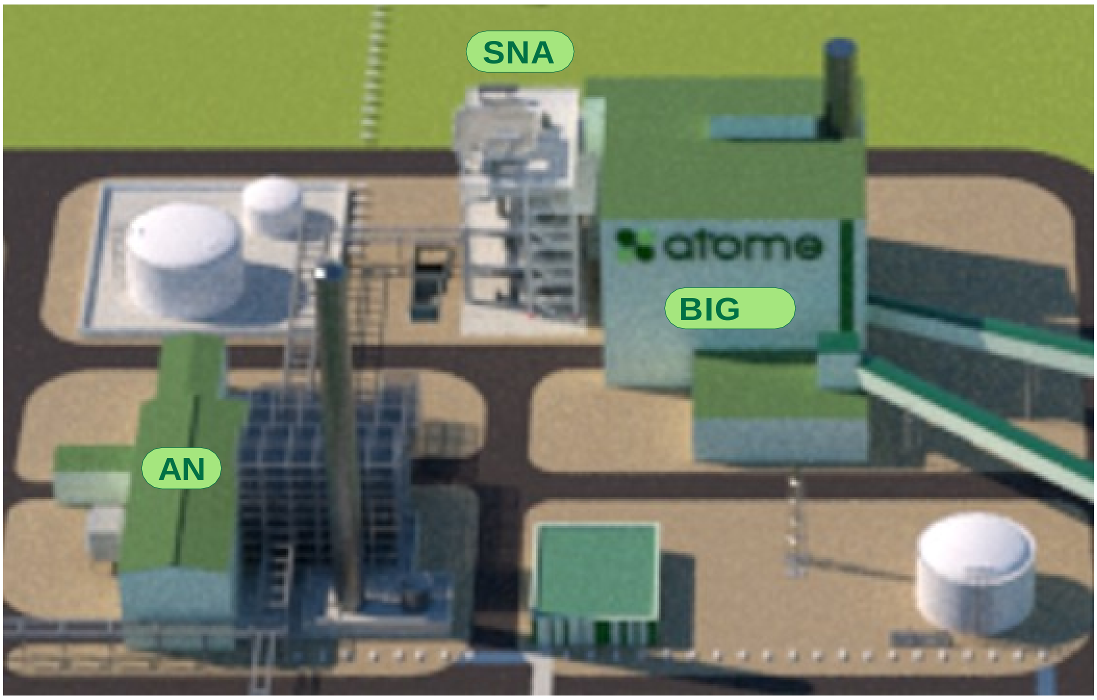
Approximately half of the ammonia produced is sent to the Nitric Acid (NA) Plant and the other half to the Ammonium Nitrate Solution (ANS) Plant. The AN and ANS will be used to make fertiliser.

Areas of the plant occupied by the air separation unit (left) and the ammonia synthesis unit (right).

Nitric Acid Plant (NA) - In this plant, ammonia is transformed into nitric acid by the double pressure process.

Ammonium Nitrate Solution (ANS) Plant - In this plant the nitric acid formed in the AN Plant reacts with ammonia in a reactor, producing ammonium nitrate.

Granulation Plant (GRAN) - This is the last stage of the ATOME Plant, where the Ammonium Nitrate Solution is converted into a type of granular nitrate-based fertiliser (CAN fertiliser).



View of the Nitric Acid (NA) Plants,
Ammonium Nitrate Solution (ANS) and Granulator (GRAN).

Flaring System - The ATOME Plant will include a flaring system to burn hazardous or flammable gases in cases of emergency or specific process conditions, discharging them afterwards to the atmosphere. The system will comply with the limits established by Paraguayan environmental legislation and international standards.

AUXILIARY PLANT INSTALLATIONS

Raw Water Collection System - The water to be used for process, service, fire fighting, cooling and drinking water will be collected from the Paraguay River and pumped to the plant. The estimated flow will be 242.70 m^3/h and the flow returned to the river will be 77.30 m^3/h, being the total water consumption 165.4 m^3/h equivalent to 0.008% of the lowest flow of the river.

Raw Water Treatment Plant - In this plant the water will be pre-treated and then part of it will be made potable and part demineralised.

Wastewater Treatment Plant (WWTP) - This plant will treat the effluent from the pre-treatment and demineralisation system, oily network, non-oily network and sanitary effluent. The treated effluent will be conducted to the Paraguay River through a buried pipeline, parallel to the raw water pipeline. The effluent will comply with the quality established in Paraguayan legislation and international standards, returning water to the river with a better quality than the existing one.

Plant Substation and High Voltage Transmission Line - The 220 kV, 550 m long transmission line will carry power from ANDE's Buey Rodeo Substation to the Plant, connecting this substation to the Plant's internal substation.

Plant Production Capacity

Hydrogen production rate	1,802.0 kg/h
Ammonia production rate	10,165 kg/h
Fertiliser production rate	31,958 kg/h

Area Directly Affected by the Project: 30 ha of plant land, the easement strips of the TL (3.30 ha or 33,000 m^2) and of the water and effluent pipelines (1.15 ha or 11,500 m^2).

Number of workers:

- Construction phase: 461 workers at the peak of the works, with a proportion to be recruited locally.
- Operation phase: 240 direct jobs, 195 permanent and 45 temporary.
  In addition, some 874 indirect jobs will be generated.

Construction schedule: The plant will be built in approximately 31 months, with 6 months for commissioning and testing.

Positive impacts of the Project: Generation of direct and indirect jobs during construction and operation; Improvement of the economy of Villeta; Reduction of Greenhouse Gas (GHG) emissions and carbon footprint.

DO YOU HAVE ANY QUESTIONS OR WOULD YOU LIKE TO MAKE A REQUEST/COMMENT?

www.atomeplc.com/projects/paraguay/
info@atomeplc.com
021 664 493

Annex 4 – Presentation of the Project and ESIA

Public Consultation

Green Hydrogen, Ammonia and Fertilizer Production Plant by ATOME Paraguay S.A.

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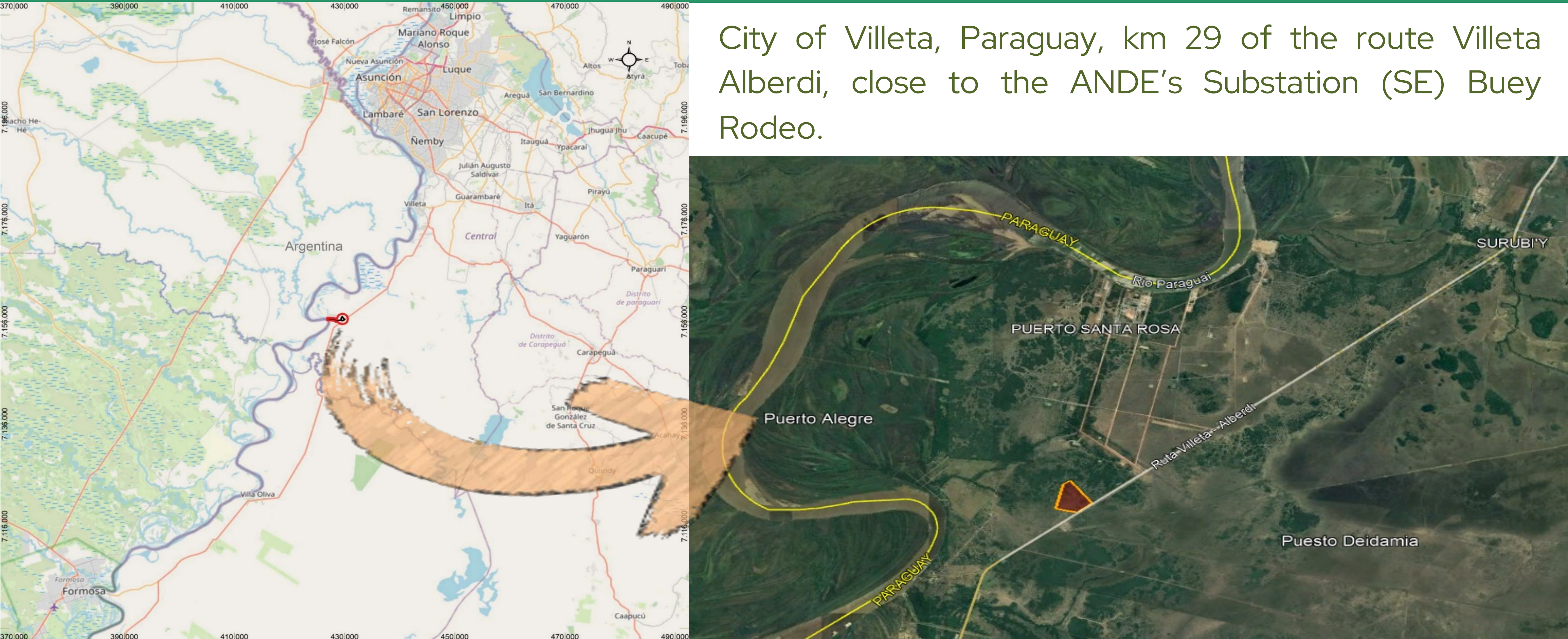
JGP

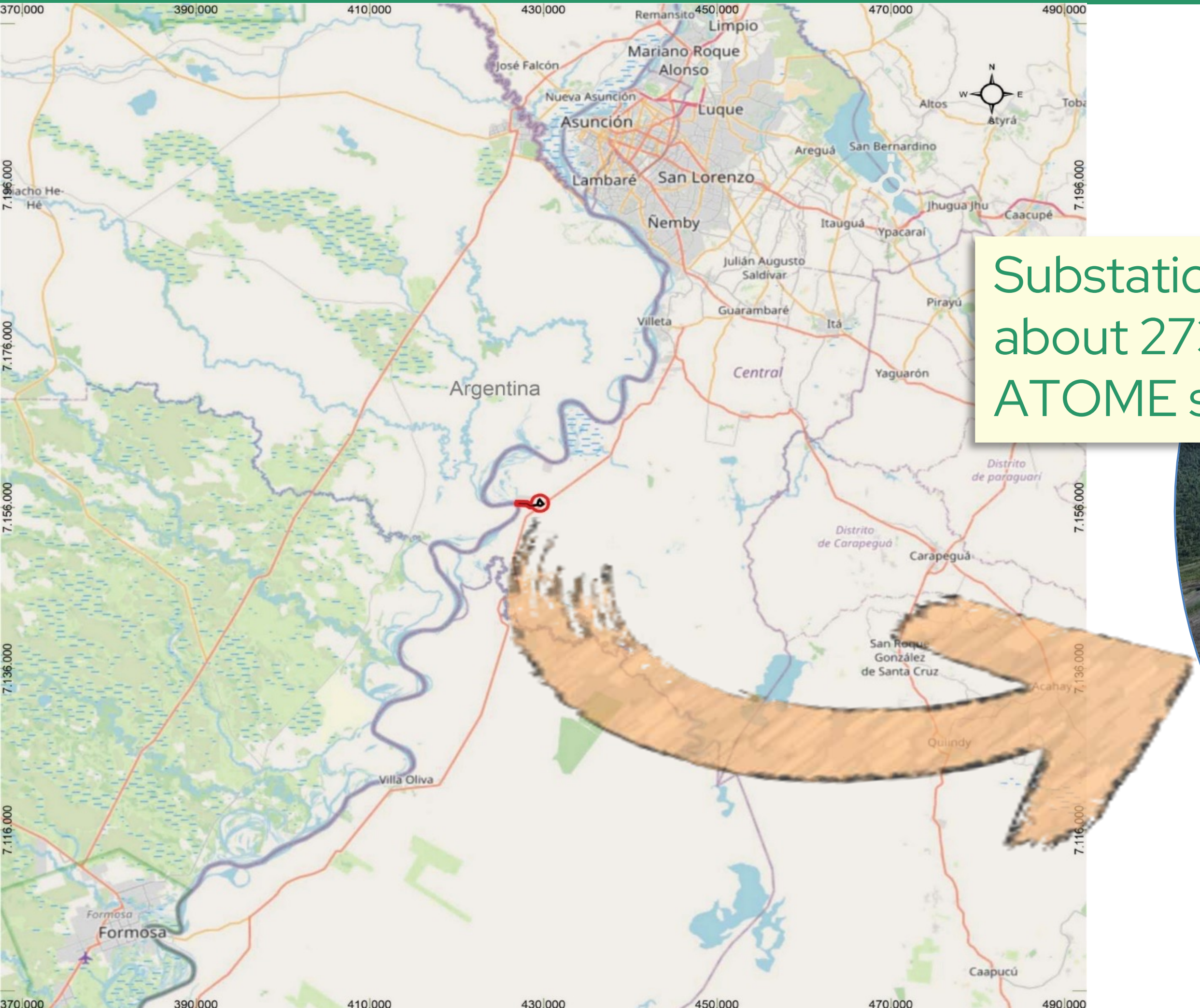
December/2023

Location

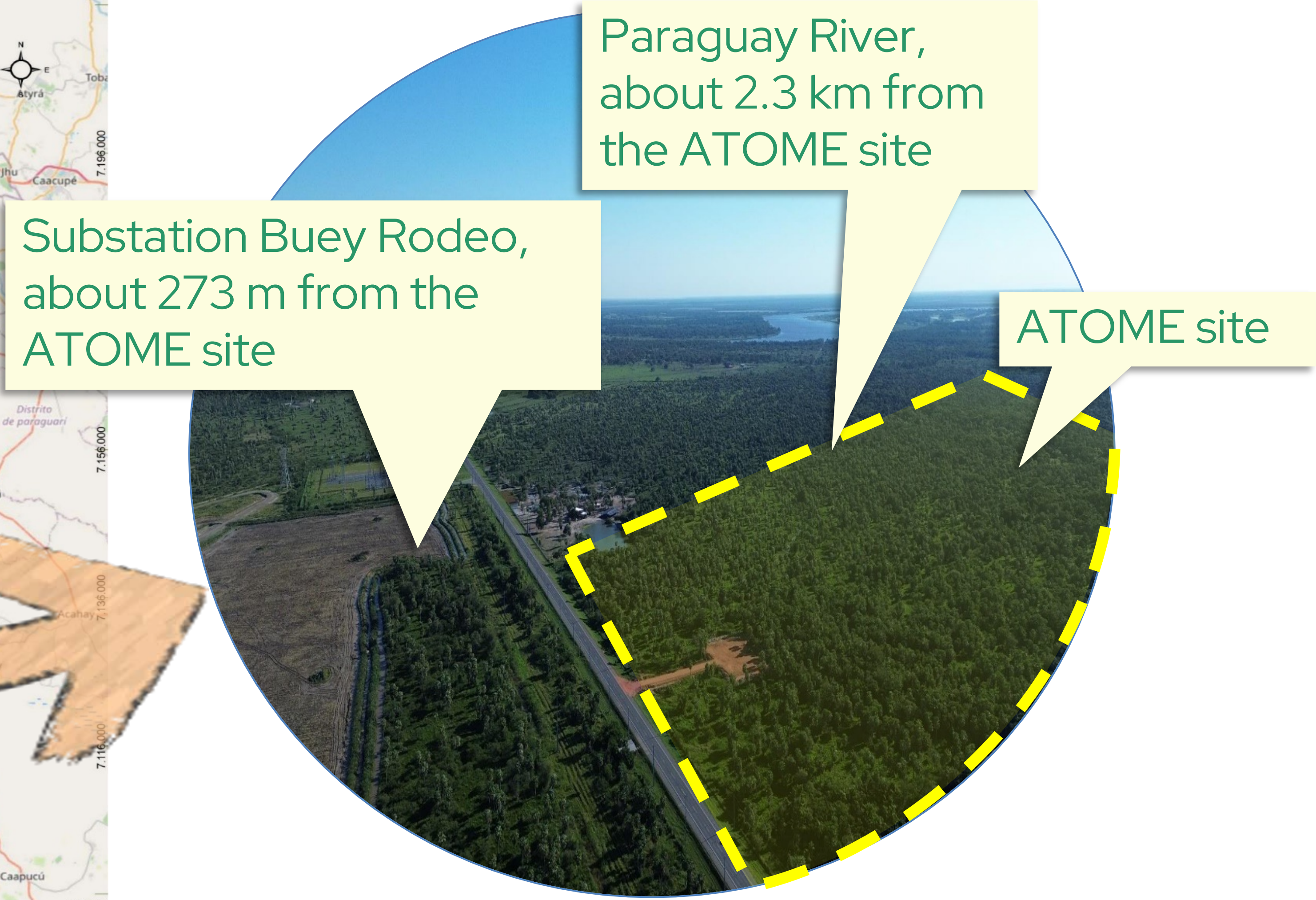
City of Villeta, Paraguay, km 29 of the route Villeta Alberdi, close to the ANDE's Substation (SE) Buey Rodeo.



Location



Limpio
Mariano Roque Alonso
José Falcón
Nueva Asunción
Asunción
Luque
Areguá
San Bernardino
Altos
Atyrá
Lambaré
San Lorenzo
Ñemby
Itauguá
Ypacaraí
Caacupé
Julián Augusto Saldívar
Guarambaré
Villeta
Itá
Pirayú
Argentina
Central
Yaguarón
Distrito de paraguarí
Distrito de Carapeguá
Carapeguá
San Roque González de Santa Cruz
Villa Oliva
Formosa
Caapucú



Paraguay River, about 2.3 km from the ATOME site
Substation Buey Rodeo, about 273 m from the ATOME site
ATOME site

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Green Hydrogen (H2)

Green Hydrogen Value Chain

Global contribution to the Paris Agreement
Mass adoption of green H2 will contribute to the global goal of limiting global warming to 1.5°C

Production	Transformation	Transport	Final Use
Renewable Energy; Water → Electrolysis → H_2	H_2 → H_2 No Transformation; CO_2 → Synthetic Fuel; N_2 → NH_3 Ammonia	Freight Shipping (River/Ocean)); Terrestre; Gas pipelines; Storage	Industry (H_2, NH_3): Steel, Chemicals, Refineries, Fertilizers; Transport (H_2, NH_3): Freight Shipping, Aviation, Light Vehicles, Trains, Heavy Trucks, Urban Passenger Buses; Thermal & Electricity Generation (H_2)

Promotion of green jobs
Creating employment opportunities in sustainable industries and developing a workforce focused on clean technologies.

Clean Fuel
Decarbonisation of the transport, heating and industrial production sector, reducing dependence on fossil fuels.

Energy Storage
On a large scale and over long periods of time, it solves the intermittency of renewable sources

Energy security
Diversification strengthens energy security by reducing dependence on limited and geographically concentrated resources

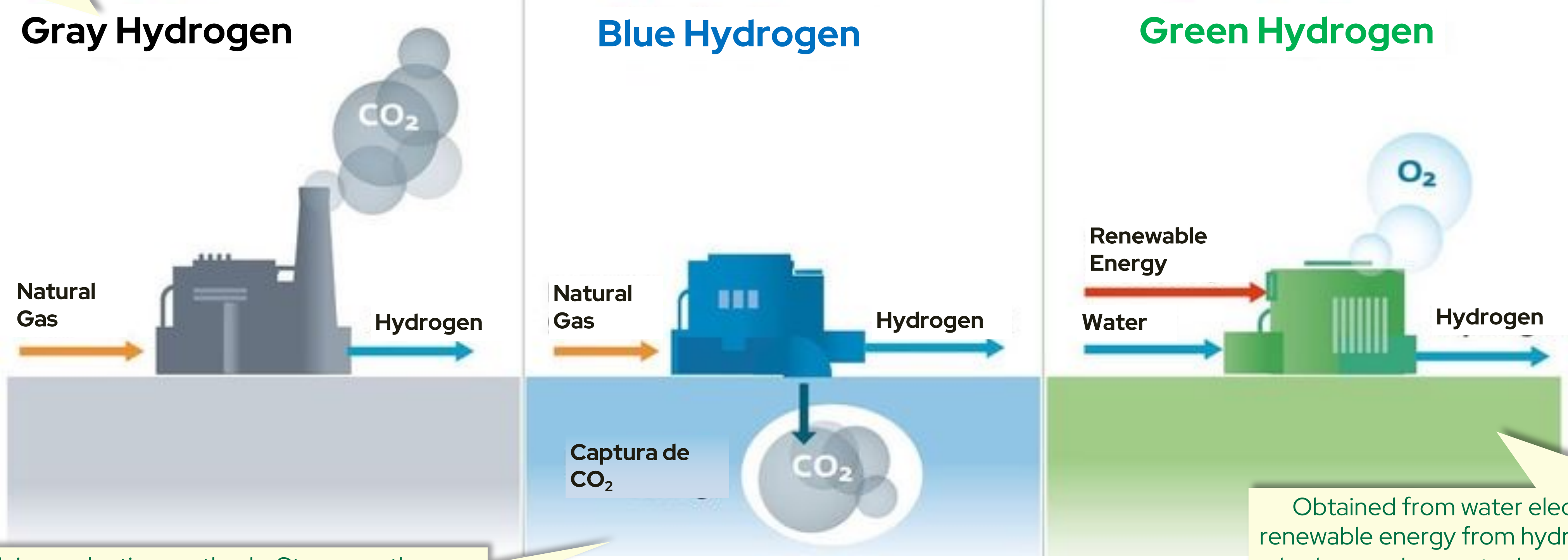
Investment Needed
Goldman Sachs – Global Investment Research estimates that $5 trillion of investment in the low-carbon hydrogen supply chain is needed to achieve net-zero emissions by 2050 [3]

1 Reuters - Ten clean hydrogen policies and initiatives from across the globe 2 Goldman Sachs – estimates of possible future scenarios 3 Goldman Sachs - Global Investment Research

Green Hydrogen (H_2)

A key element for the energy transition

More than 95% of today's hydrogen is produced from fossil fuels



Main production methods: Steam methane reforming and coal gasification.
Both processes release carbon dioxide (CO2)

Obtained from water electrolysis and renewable energy from hydropower, green hydrogen does not release greenhouse gases

Green Hydrogen H_2

For the production of ammonia and green fertilizer

Raw Materials

- Renewable energy
- Water
- Aiir

Electrolysis

Green Hydrogen

- For ammonia production
- Zero emission transport (**Mobility Project**)

Ammonia Synthesis

Ammonia

- Fertilizer Production (**Latin America**)
- Marine Fuel(**Island**)

Nitric Acid Limestone

CAN+

- Green Fertilizer (**Villeta Project**)

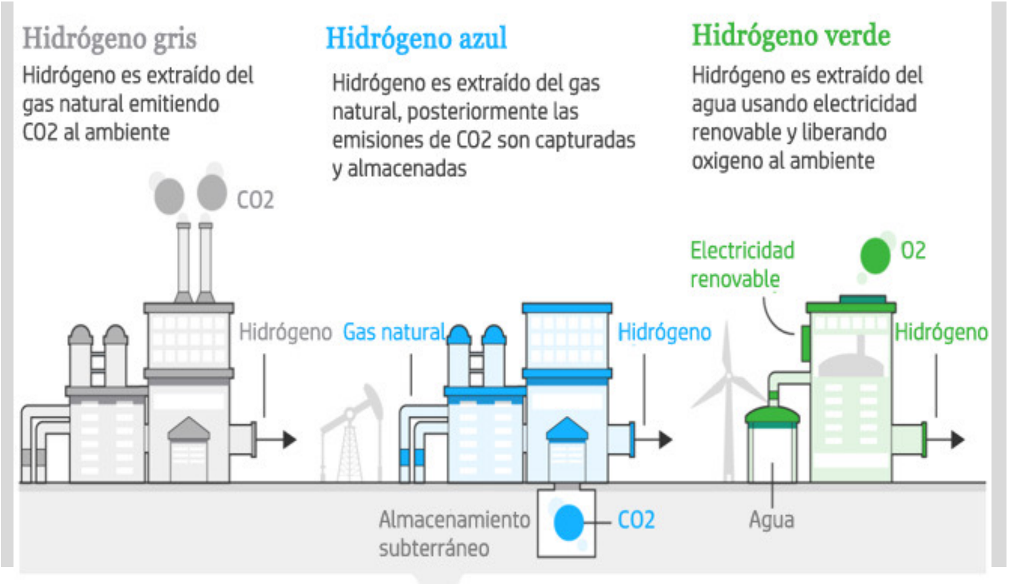
Displacement of grey hydrogen: More than 95% of today's hydrogen is produced from fossil fuels.

Transition to green energy: Low-carbon hydrogen could supply up to 25% of the world's energy by 2050, with a global use of 450 million tonnes of green hydrogen [1] Hydrogen is considered the green fuel of the future and a potential substitute for fossil fuels, making it one of the key strategies to achieve "decarbonisation" by 2050 as encompassed in international agreements.

Economy of scale: The low-carbon or clean hydrogen sector is expected to generate $2.5 trillion in revenue by 2030, creating 30 million jobs [2].

Government Support: $370 billion IRA investments in the U.S. for climate and clean energy. The EU's €800 million Green Deal. The UK's Net Zero Hydrogen Fund.

Investment needed: $5 trillion of investment in the low-carbon hydrogen supply chain is required to achieve the goal of zero emissions [3].



1. Reuters - Ten clean hydrogen policies and initiatives from across the globe, 2. Goldman Sachs – estimates of possible future scenarios 3. Goldman Sachs - Global Investment Research

The Project

Green Fertilizer (CAN)

Project Components

- Hydrogen, Ammonia and Green Fertilizers production plant.
- 220 kV electrical transmission line (LT) and about 550 m long.
- Water catchment system from the Paraguay River to the ATOME Plant and effluent discharge pipes.

¿Why the Plant Is Considered Green?

The production of hydrogen from water will use electricity from a renewable energy source, in this case hydroelectric (energy produced at the Itaipu plant).

By not using fossil fuels as raw materials and for electricity generation, the Project foresees a reduction in greenhouse gas (GHG) emissions and their contribution to climate change.

The Project

Green Fertilizer (CAN)

Transporte

CAN – Nitrato de amonio y calcio 250.000 t/año - (757 t/dia)

Consumo nacional:
- Transporte terrestre en camiones pesados de 30 t/viaje de capacidad.
- 700 viajes/mes previsto con una flota de 15 camiones pesados (~2 viajes por día)

Exportación:
- 170 barcazas fluviales anuales desde Puerto de Villeta hasta Puerto de Montevideo.
- Transporte marítimo desde Montevideo hasta Puertos de Sao Paulo, Rio Grande, Camacari.

Desarrollo de la economía del hidrógeno verde

Generación de empleos verdes
- Capacitación en nuevos procesos industriales, mantenimiento, gestión, administración, logística.

Nuevas cadenas de valor
- Desarrollo industrial en la zona con nuevas plantas de transformación y empresas de servicio.

Distribución y logística
- Alcance al consumo final en el país, nuevos almacenes y centros de distribución.

Agricultura local
- Menores costos e independencia del mercado internacional.

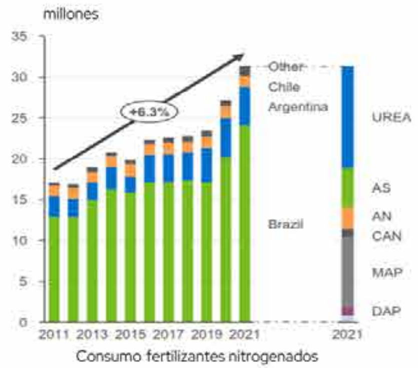
Uso del CAN

Superficie de cultivos en Brasil
- 43 mill ha. de Soja
- 21,9 mill ha. de Maiz
- 8,32 mill ha. de Caña de Azúcar
- 3 mill ha. de Trigo
- 1,5 mill ha. de Arroz

Superficie de cultivos en Paraguay
- 3,7 mill ha. de Soja
- 800.000 ha. de Maíz
- 450.000 ha. de Trigo
- 170.000 ha. de Arroz
- 105.000 ha. de Caña de azúcar

Superficie cubierta por ATOME (promedio)
- Maíz 450.000 ha*
- Caña de azúcar 1.270.000 ha**
- Arroz 2.500.000 ha***

Mercado de Fertilizantes
- LatAm depende en gran medida de las importaciones de fertilizantes nitrogenados para respaldar sector agrícola.
- Brasil es el 4to mayor importador en el mundo y es responsable del 8% del consumo global.
- Paraguay es importador neto con alta fuga de divisa de más US$ 600 mill.



Consumo fertilizantes nitrogenados

Emisiones por uso
- El reemplazo de urea por CAN verde reducirá las emisiones de NOx y CO2 relacionadas a su uso en cultivos (lixiviación de nitrógeno, volatilización, nitrificación

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The Project

Green Fertilizer (CAN)

Investment & Impact

$>400 mill
Capital investment for the production plant of Hydrogen, Ammonia and Green Fertilizers

+1300
Direct and indirect jobs generated in the construction phase

+1100
Direct and indirect jobs generated in the operational phase

Fertilizer market

27 Mt
Annual fertilizer imports in the Mercosur region

$600 mill
Paraguayan market covered entirely by imports with foreign exchange outflows

1,2 mill
hectares of sugarcane can be fertilized with the ATOME product

Environment & Society

~500.000
t CO_2-eq/year avoided by ATOME's green fertilizer production

160.000
ton/year of medical oxygen that will be available to the local market

100%
Renewable energy for the production of hydrogen, ammonia and green fertiliser

ATOME will be one of the first companies in the world to use green ammonia to produce 100% green products on an industrial scale and reduce emissions in the fertilizer sector

The Project

Green Fertilizer (CAN)

Use of CAN

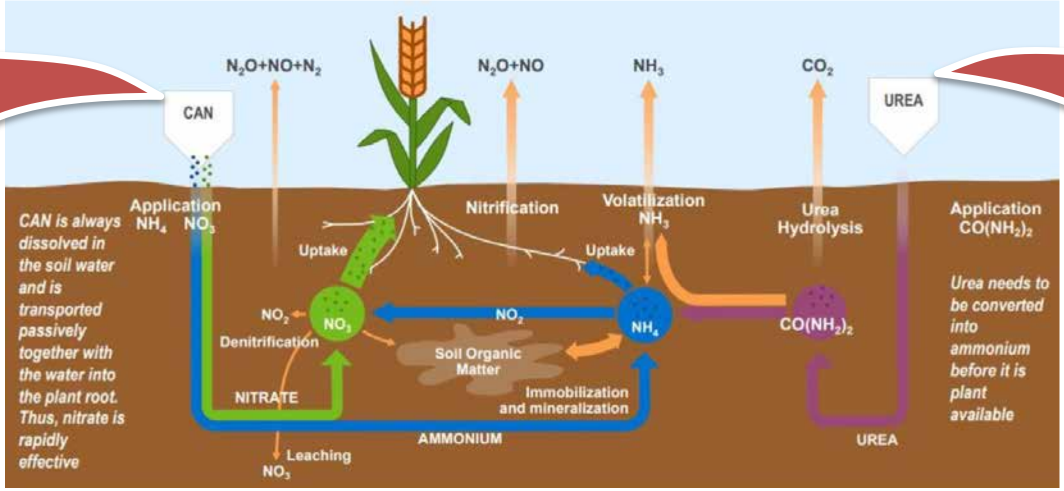
- The replacement of urea with green CAN will reduce NOx and CO2 emissions related to its use in crops (nitrogen leaching, volatilization, nitrification and hydrolysis of urea).

Comparison with other fertilizers

Annual emissions avoided

473,753 t CO2e/año

CAN always dissolves in soil water and is passively transported along with the water to the root of the plant. Therefore, nitrate is quickly effective



Urea CO(NH2)2 must be converted to ammonium before it is available to the plant

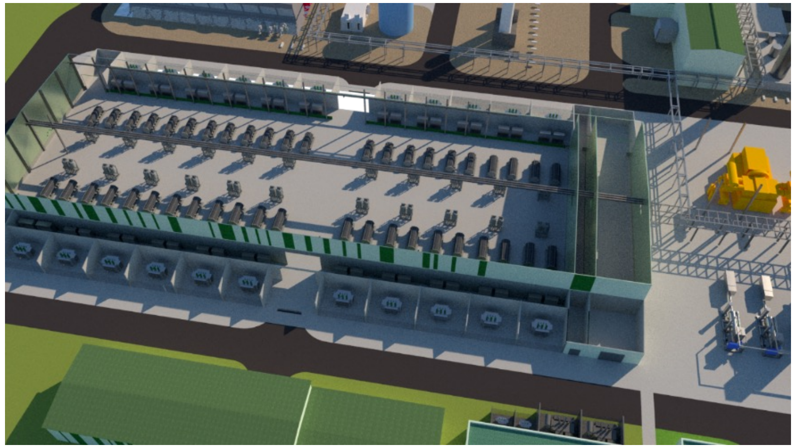
atome | Main Plant Facilities

Green Hydrogen (H2) Plant
It will produce hydrogen using energy that comes from the ANDE's Buey Rodeo Substation (SE), through a transmission line that is also part of the Project.

Air Separation Unit
It captures air and separates nitrogen from other gases that make up the air. The nitrogen is then used to produce ammonia.

Ammonia Synthesis Unit
This part of the plant houses the reactor where ammonia is produced from the mixture of hydrogen and nitrogen.

~50% of the ammonia goes to the Nitric Acid (AN) Plant and the other half to the Ammonium Nitrate Solution (AN) Plant. The NA and SNA will be used to make the fertilizer.


Hydrogen Production Plant


Haber-Bosch Reactor

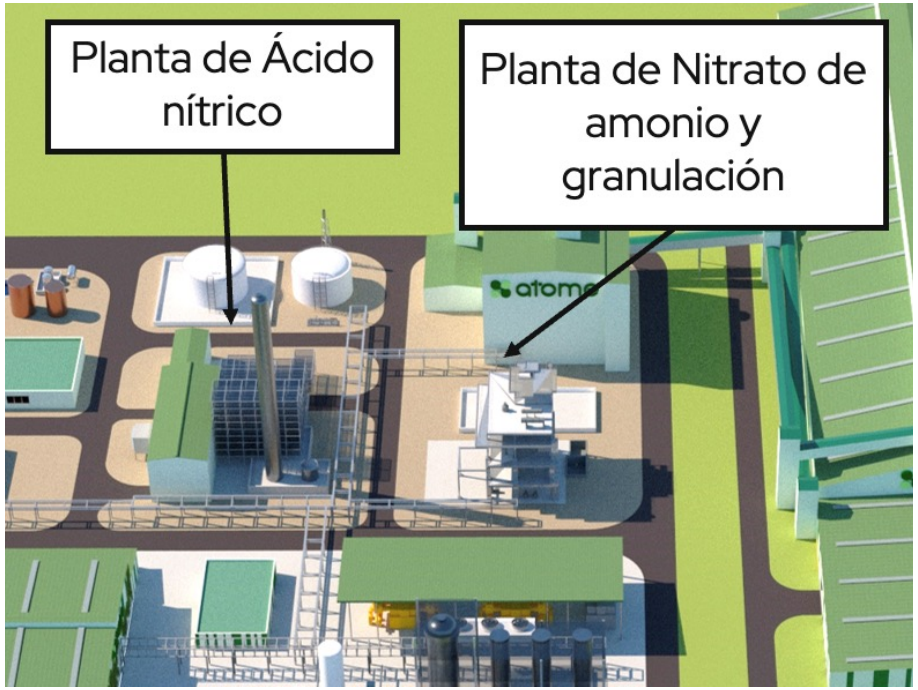
Main Plant Facilities

Nitric Acid Plant (AN)
In this plant, ammonia is transformed into nitric acid using the double-pressing process.

Ammonium Nitrate (SNA) Solution Plant
In this plant, nitric acid formed at the AN plant reacts with ammonia in a reactor, producing ammonium nitrate.

Granulation Plant (GRAN)
This is the last phase of the Atome Plant, where the Ammonium Nitrate Solution is converted into a type of nitrate-based granular fertilizer (CAN fertilizer).

Flare System
The flare system is used to burn hazardous or flammable gases in cases of emergency or specific process conditions, and then discharge them into the atmosphere. The system will comply with the limits established by Paraguayan environmental legislation and international standards.



Nitric Acid (AN), Ammonium Nitrate Solution (ANS) and Granulator (GRAND) Plants)

Auxiliary Plant Facilities

Raw Water Intake System

The water will be used for processing, firefighting, refrigeration and drinking water. It will be taken from the Paraguay River and pumped to the plant. The total consumption will be 165.4 m^3/h, equivalent to 0.008% of the lowest flow of the river.

Raw Water Treatment Plant

In this plant, the water will be pre-treated and then part will be purified and part will be demineralized.

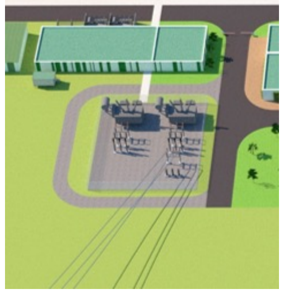
Raw Water Treatment Plant and WWTP

Wastewater Treatment Plant (WWTP)

The effluents will comply with the quality established in Paraguayan legislation and international standards, returning water to the Paraguay River with a better quality than the existing one, through a buried pipe, parallel to the raw water pipe.

High Voltage Transmission Line and Plant Substation

The 220 kV transmission line with a 550 m extension will carry power from ANDE's Buey Rodeo Substation (SE) to the Plant, connecting this SE to the internal SE of the Plant.



Internal SE and LT 220 kV input

atome | Operation and maintenance aspects

Productive Capacity of the Plant

Production rate of CAN fertilizer	250.000 ton/year

Raw Materials and Inputs

Raw Materials	Source	Quantity
Water (net consumption)	Paraguay River. Option: Paraguay River and deep wells (fire fighting system only)	165.4 m3/h (0.008% of the lowest flow of the Paraguay River)
Ambient air	Air Separation Unit	201 ton/day
Electric power (hydropower)	ANDE's Buey Rodeo substation through a 220 Kv LT	Total electrical power consumption = 112.9 MW
Limestone	Existing quarries under evaluation	173 ton/day

Granulated Calcium Ammonium Nitrate (CAN) Fertilizer

Environmental Controls During Operation

Liquid Effluents

The effluents will be treated in a Wastewater Treatment Plant (WWTP) to comply with national and international standards.

Solid Waste

Sludge, waste oils, polluted process water, worker-generated waste, electrical waste and mechanical waste will be collected, separated, sorted, stored and disposed of.

Atmospheric Emissions

Part of the continuously emitted gases are non-polluting and will be vented to the atmosphere = H_2, N_2, H_2O, O_2 and Argon.

The volumes of air pollutants are very small, including CO_2, NO_x, N_2O, CO, SO_2, NH_3, particulate matter for which there will be control mechanisms such as the flare system.

All national and international standards for emissions and air quality will be complied with, in addition to constant monitoring.

Noise

The equipment will be designed to comply with Paraguayan and international legislation.

Alternatives Analysis

The studies of alternatives were carried out with the aim of achieving a Project with the best possible technology and seeking the most suitable location for its construction and operation, in order to cause the minimum environmental and social impact.

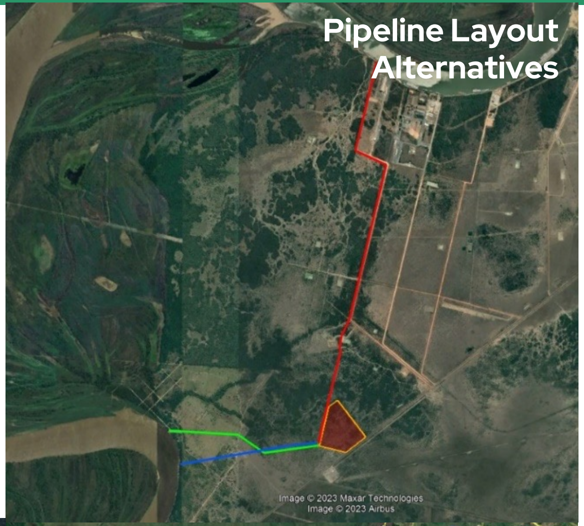
Location Alternatives

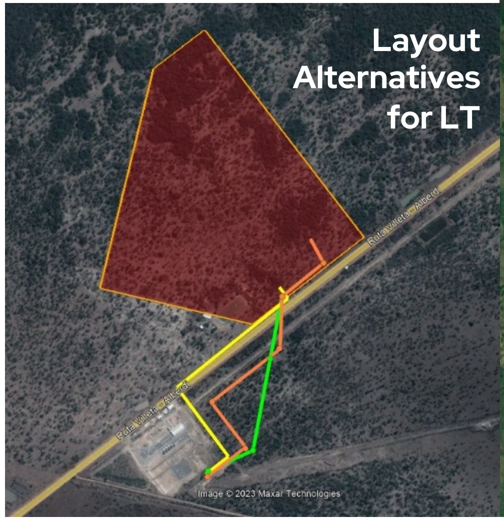
- Land alternatives for the implementation of the Plant
- Transmission Line Layout Alternatives
- Routing Alternatives for Water and Wastewater Pipelines

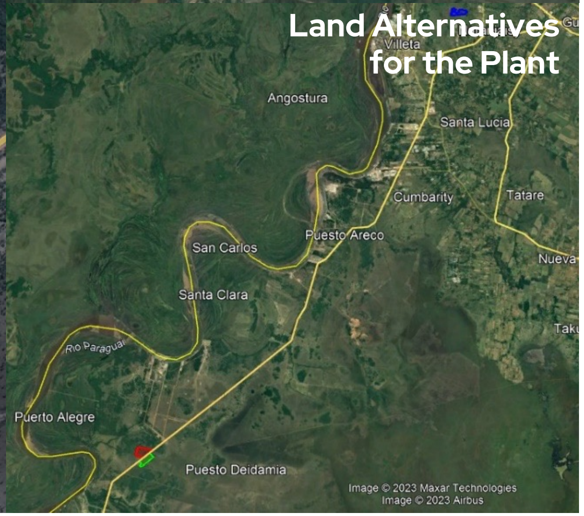
Economic and Technological Alternatives

- H2 Electrolysis
- Recovery of products from the air
- NH3 Synthesis
- CAN Storage
- Cooling system
- Water Treatment
- Water source for the process

Alternative without Project







atome

Diagnosis (baseline) Physical Environment

JGP

Clima

Clima subtropical

Verano caluroso, con temperatura promedio del mes más caluroso por encima de los 22ºC.

Temperatura Promedio anual en la zona

22ºC con amplitud de 10ºC. Verano - puede superar los 40ºC, con promedio de 27ºC y humedad relativa de ~ 80%. Invierno y primavera - promedio de 17ºC.

Precipitación promedia anual en la zona

~ 600 mm por la distancia del océano. Meses más secos - julio y agosto, con precipitación < 60 mm.
Meses más lluviosos - noviembre y diciembre, con precipitación > 170 mm.

Acontecimientos extremos y desastres naturales

	Amenaza	Riesgo
Déficit Hídrico	Media	Media
Inundación (precipitación excesiva)	Media	Baja
Inundación (desbordamiento)	Media	Baja
Inundación (conjunta)	Baja	Baja
Heladas	Media	Media
Incendios Forestales	Alta	Baja
Tormenta Severa	Alta	Alta

Diagnosis (baseline)
Physical Environment

atome

JGP

Recursos Hídricos

Río Paraguay
Caudal medio anual - 3,279 m³/s (caudal a captar por el Proyecto = 0.0021% de este total)
Caudal mínimo - 2,701 m³/s (caudal a captar por el Proyecto = 0.0025% de este total)

Usos del Agua en el AII
53.07% - fuente subterránea (caudal de 15,069 m³/s)
28.62% - fuente superficial (caudal de 8,126 m³/s)
18.31% - otros (caudal de 5,199 m³/s)

13,325 m³/s, distribuidos para industrias (60.35%, caudal de 8,042 m³/s); usos agropecuarios, incluyendo arroceros (29.25%, caudal de 3,898 m³/s), y estaciones de servicios y lavaderos (10.39%, caudal de 1,385 m³/s).

Calidad del agua en el río Paraguay
Muestreo en dos campañas – marzo (C1) y junio (C2) de 2023
Algunos valores superan los límites de la Resolución Nº 222/2002: cor aparente, Nitrógeno total, Fósforo total, Aceites y grasas, Aluminio, Hierro soluble, Cromo hexavalente (en C1 y C2), y Oxígeno disuelto y Manganeso (en C1).

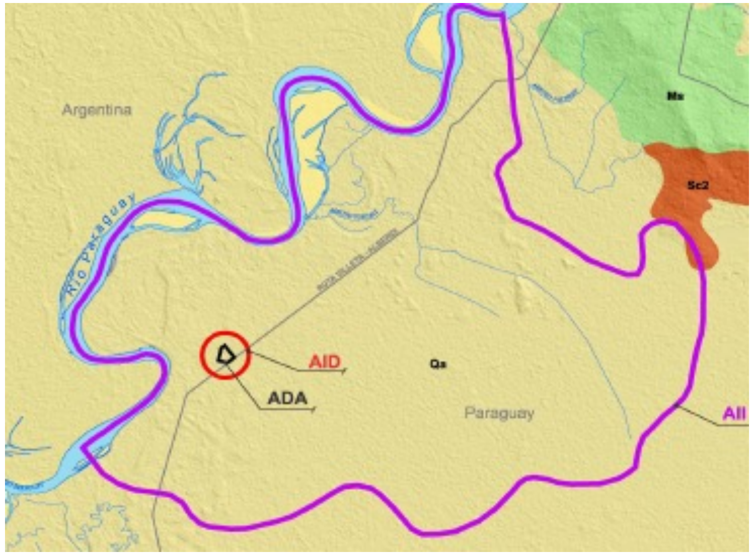
Calidad de los sedimentos de fondo
Muestreo en una campaña – septiembre de 2023
Casi todos los parámetros cumplen el valor inferior de los dos límites de la norma canadiense (Paraguay no tiene norma de calidad de sedimentos). Sólo el Níquel está en el intervalo de valores en el que ocasionalmente pueden producirse efectos adversos en la biota acuática.

Puntos de muestreo de agua y sedimentos

Geología

Unidades geológicas en el AII:

Grupo Caacupé y Sedimentos Cuaternarios



Mapa de Geología

Bloques de areniscas gruesas a medias y bien estratificadas, relacionadas con el Grupo Caacupé

Depósitos aluviales entre la desembocadura del Arroyo Zanja Mercedes y Amarradero Cargil Ypekae

Diagnosis (baseline) Physical Environment

JGP

Geomorfología

Tipos de relieve en el AII:

Cerros, Llanuras Bajas y Llanuras de Inundación

Cerros ubicados en el Distrito de Nueva Italia, conformados por areniscas del Grupo Caacupé

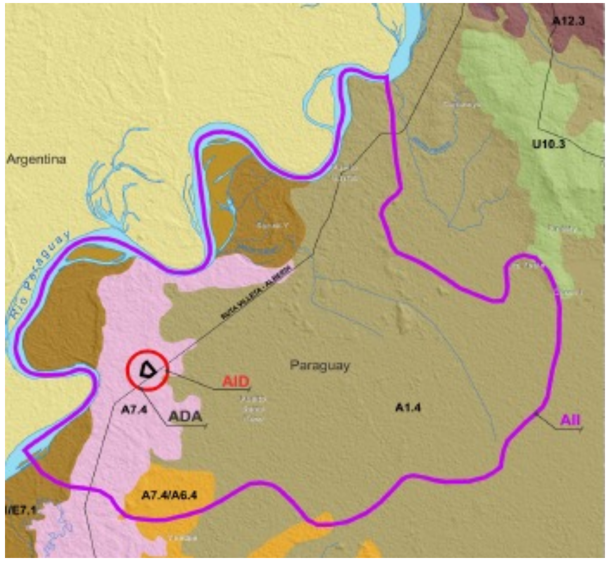
Relieve plano a semiplano del terreno “llanuras bajas”. A la derecha se ve el cultivo de arroz

Relieve de llanuras de inundación, visto a partir del río Paraguay, aguas abajo del Puerto Londrina

Diagnosis (baseline) Physical Environment

Tipos de suelos en el AII: Alfisol, Entisol y Ultisols

Suelos



Mapa de Suelos


Exposición de suelo del grupo Alfisol a orillas del río Paraguay, cerca de Puerto Londrina


Suelo del grupo Entisol a orilla del río Paraguay, cerca de la localidad de Puerto Alegre, sobre depósitos aluviales

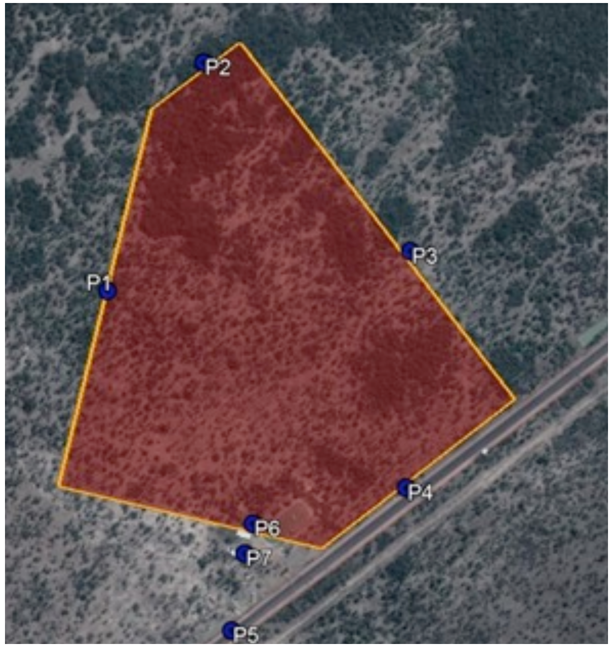
Diagnosis (baseline)
Physical Environment

Ruido

Línea base de ruido en tres campañas

- 1ª campaña - Mediciones diurnas y nocturnas de 15 min.
- 2ª campaña - Medición en P6 por 4 horas consecutivas.
- 3ª campaña - Mediciones de 20 horas continuas en los 4 puntos.

Resultado de las mediciones: el área ya presenta un ruido ambiental superior a los estándares establecidos para áreas residenciales, que es la situación actual (sin la planta en funcionamiento).



Puntos 1ª y 2ª campañas

Puntos 3ª campaña

Diagnóstico (línea de base) Medio Físico

JGP

Calidad del Aire

Línea base de calidad del aire en tres campañas, durante 24 h, realizadas entre agosto y septiembre de 2022

- Parámetros medidos: Material Particulado (PM10 y PM2.5), monóxido de carbono (CO), óxido de nitrógeno (NO_2), ozono (O_3) y óxido de azufre (SO_2).

Equipo utilizado en la medición

Lugar de instalación de la estación de monitoreo de la calidad del aire

Resultado de las mediciones: los niveles ambientales de los contaminantes atmosféricos monitoreados estuvieron siempre por debajo de los estándares de calidad del aire establecidos por la Resolución SEAM Nº 259/2015, la OMS 2021 - Directrices Mundiales de Calidad del Aire y las Guías generales sobre medio ambiente, salud y seguridad de la CFI.

Diagnosis (baseline)
Biotic Environment – Flora

Área	% de vegetación nativa	% de Sabana	% de Bosque
AID	65.2	42.9	22.3
Terreno de la Planta	99.2	78.8	22.4
Franja de servidumbre de la LT	23.7	23.3	0.4
Franja de servidumbre de las tuberías de agua y efluentes LT	60.0	48.4	11.6

Muestreo realizado en el ADA:

- Bosque: 26 especies entre arbóreas, arbustivas y palmeras, de 14 familias.
- Sabana: 72 especies pertenecientes a 29 familias.

Especies amenazadas presentes en el sitio

Especie	Nombre común	Estado de conservación (MADES)	Estado de conservación (IUCN)
Cohniella jonesiana (Rchb. f.) Christenson	Orquídea	En Peligro de extinción	-
Cynophalla retusa (Griseb.) X. Cornejo & H.H. Iltis	Arbusto	-	Casi amenazada (NT)
Libidibia paraguariensis (D. Parodi) G.P. Lewis	Guayacán	En Peligro de extinción	Vulnerable (VU)
Monteverdia ilicifolia (Mart. ex Reissek) Biral	Kangorosa	En Peligro de extinción	-
Prosopis nigra (Griseb.) Hieron	Algarrobo negro	Amenazada de extinción	Deficiente de datos (DD)

Vista del mosaico bosque/sabana palmar

Diagnosis (baseline)
Biotic Environment – Fauna

Muestreo realizado en el ADA (2 campañas):

- Aves: 2,140 registros, 138 especies, 22 órdenes y 43 familias.
- Herpetofauna: 27 especies, 21 de anfibios y 6 de réptiles.
- Mamíferos medianos y grandes: 85 registros, 12 taxones, 7 órdenes y 9 familias.
- Murciélagos: 591 registros, 14 taxones, 3 familias.

Especies amenazadas presentes en el sitio

	Especie / Nombre común	Estado de conservación (MADES)	Estado de conservación (IUCN)
Aves	*Amazona aestiva* / loro manchado menor	-	Casi amenazada (NT)
Herpetofauna	-	-	-
Mamíferos medianos y grandes	-	-	-
Murciélagos	*Peropteryx macrotis*	En Peligro de extinción	-
	Myotis ruber	-	Casi amenazada (NT)
	Myotis simus		Deficiente de datos (DD)
	Cynomops abrasus		Deficiente de datos (DD)

Búsqueda de rastros de anfíbios y réptiles


Equipo para muestreo de murciélagos


Tangará


Rana, Ju'i

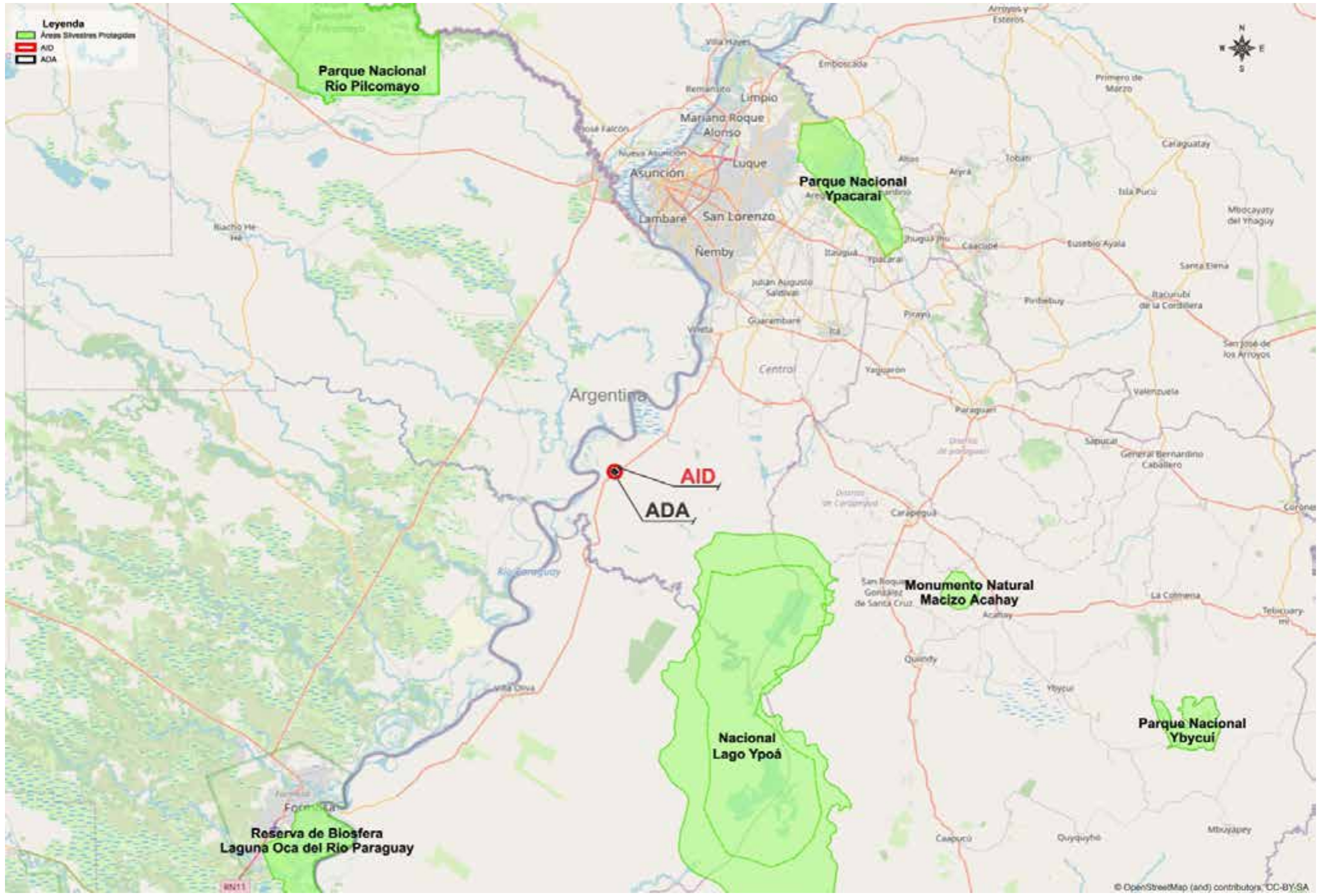

Corzuela parda


Diagnosis (baseline)
Protected Areas

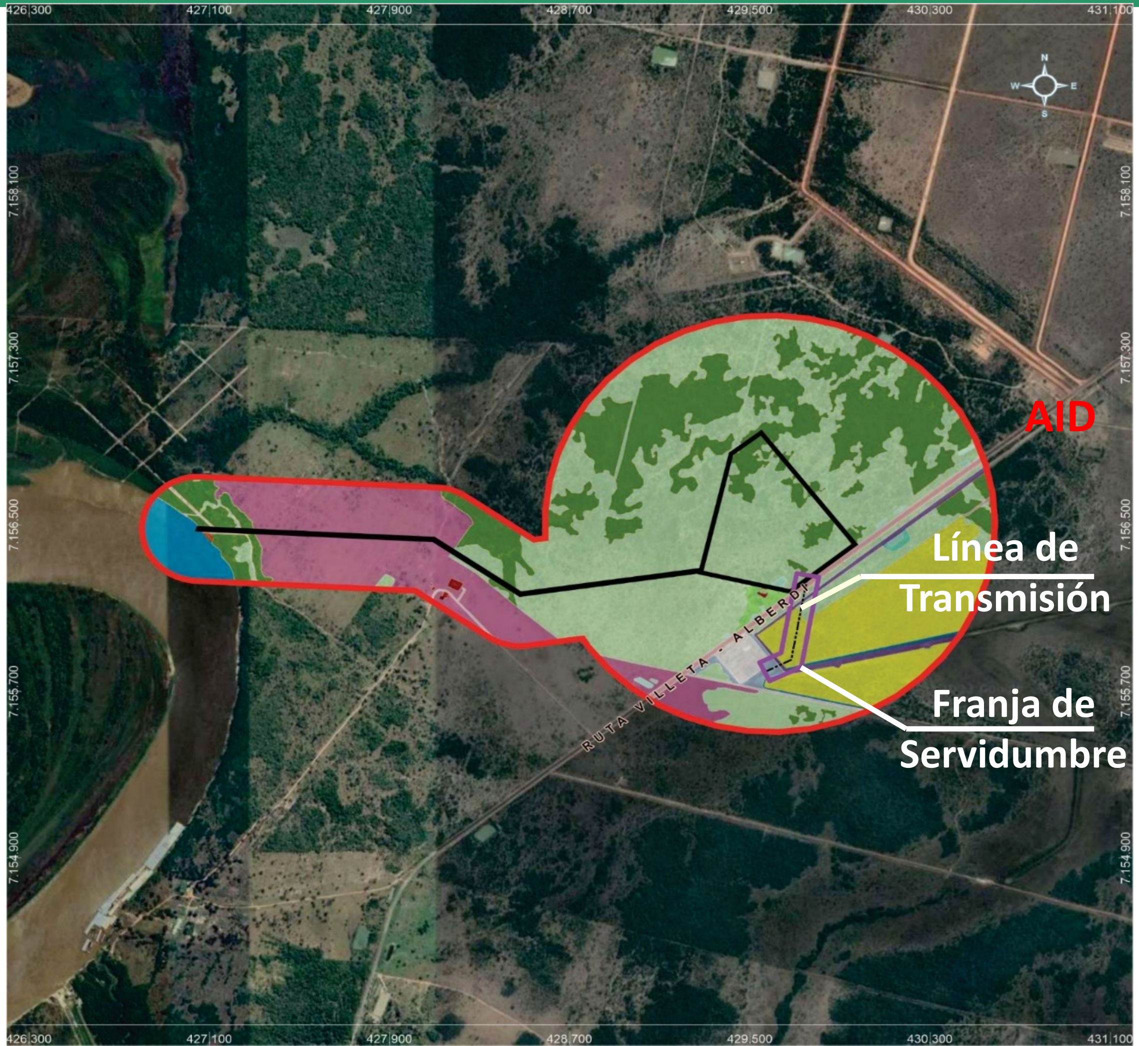
Áreas Protegidas

El proyecto no interfiere con Áreas Silvestres Protegidas (ASP).

ASP más cercanas: Reserva Natural Guyrati y Parque Nacional Lago Ypoá, que se encuentran a unos 3 km del límite del AII.



Diagnosis (baseline)
Land Use and Vegetation Cover



Uso Actual

- Río Paraguay
- Pastizal inundable
- Línea de transmisión
- Construcción rural
- Canales
- Suelo
- Bosque sub-húmedo
- Sabana
- Cultivo
- Pasto
- Uso silvopastoril
- Áreas Antrópicas
- Caminos
- Subestación
- Tajamar

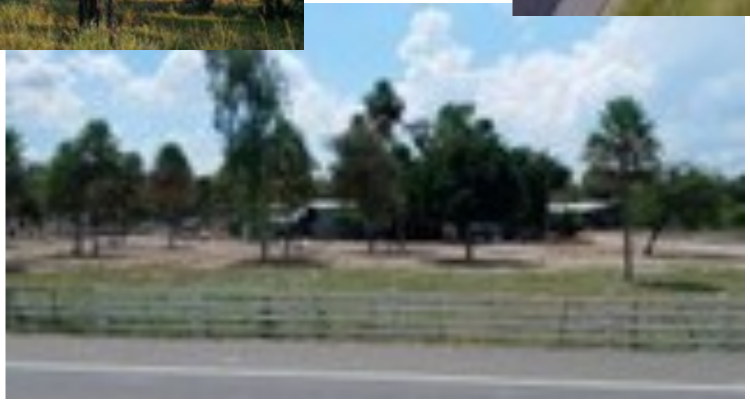
Diagnosis (baseline)
Land Use and Vegetation Cover

Categorías de Uso del Suelo

Bosque

Sabana

Pasto



Uso Silvopastoril

Cultivo

Diagnosis (baseline)
Socio-economic environment

Neighboring property

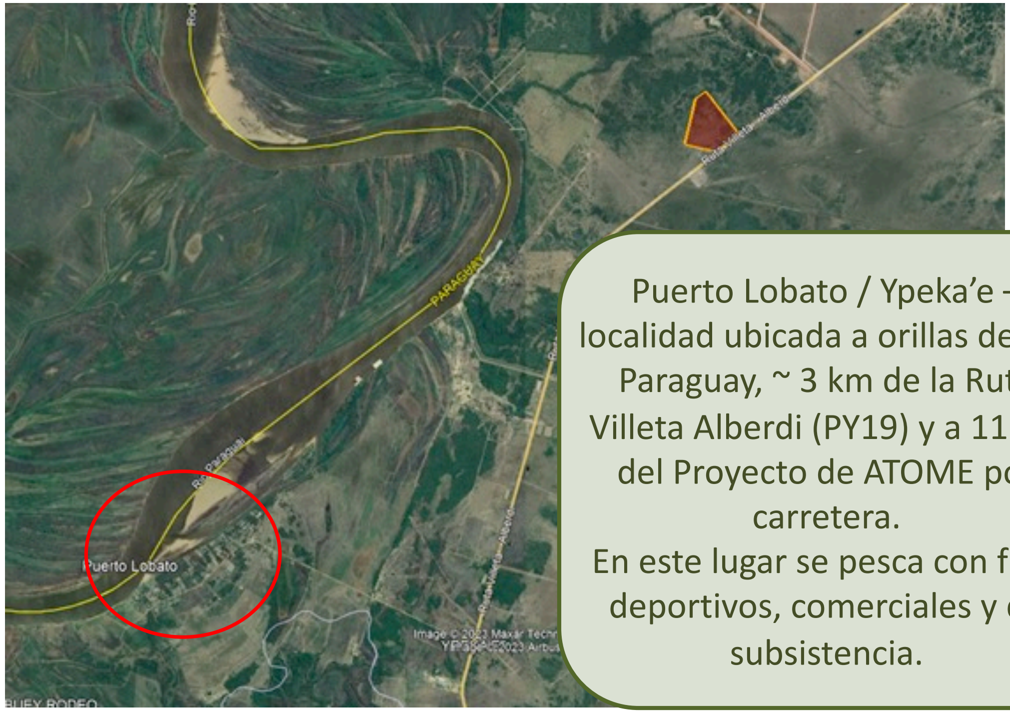
Límites del terreno de ATOME y la propiedad vecina

Propiedad vecina al terreno de ATOME

Diagnosis (baseline)
Socio-economic environment

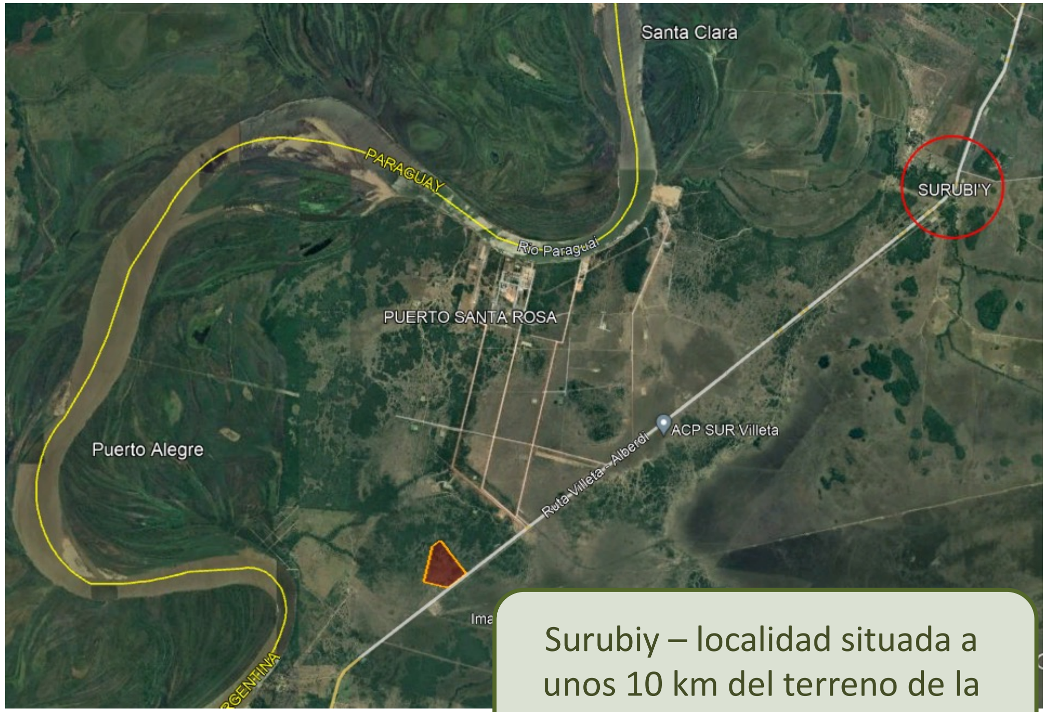
Comunidades cercanas

Ubicación de Puerto Lobato / Ypeka'e en relación con el terreno de la Planta



Puerto Lobato / Ypeka'e – localidad ubicada a orillas del río Paraguay, ~ 3 km de la Ruta Villeta Alberdi (PY19) y a 11 km del Proyecto de ATOME por carretera.
En este lugar se pesca con fines deportivos, comerciales y de subsistencia.

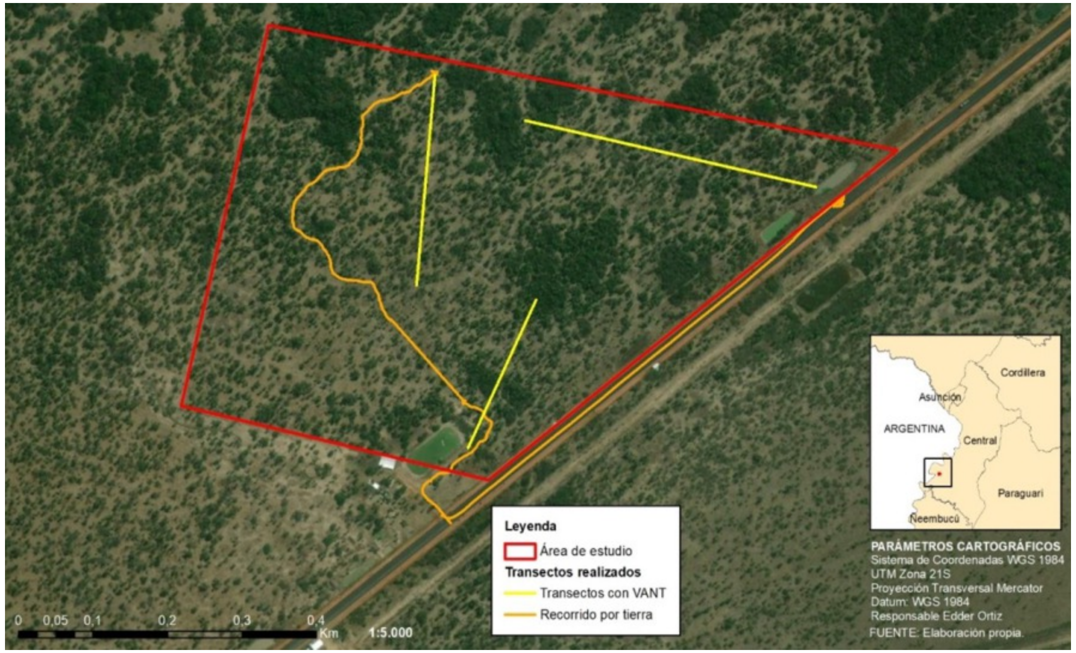
Ubicación de Surubiy en relación con el terreno de la Planta



Surubiy – localidad situada a unos 10 km del terreno de la Planta por carretera.

Diagnosis (baseline)
Socio-economic environment

Patrimonio Arqueológico



Zonas de muestreo arqueológico y recorridos en el ADA


Recorridos y prospección arqueológica de superficie en sabana palmar con uso de dron

No se encontraron elementos o vestigios culturales, debido a la vegetación presente, además de presentar modificaciones en el uso del suelo y remoción. Sin embargo, se visualizaron áreas de potenciales usos humanos.

Metodología

Acciones impactantes x Componentes impactables de los Medios Físico, Biótico y Socioeconómico

↓

Impactos potenciales y riesgos x Medidas de prevención, control, mitigación y compensación de impactos (Plan de Gestión Ambiental y Social – PGAS)

Atributos de Calificación:

- Naturaleza (positivos o negativos)
- Localización (AII, AID o ADA)
- Etapa (planificación, construcción o operación)
- Incidencia (directo o indirecto)
- Inducción (Inmediato, Corto, Medio o Largo Plazo)
- Duración (Corto, Medio o Largo Plazo, Permanente)
- Reversibilidad (Reversible, Parcial o Irreversible)
- Probabilidad (Baja, Media o Alta, Cierto)
- Magnitud (Alta, Media, Baja)
- Importancia (Alta, Media, Baja)

Importancia del impacto resultante x Grado de mitigabilidad

↓

Importancia residual

Identification of Main Impacts

Construcción: impactos temporales, incluyendo aparición o aumento de erosiones, potencial contaminación del agua y del suelo, aumento del ruido y las vibraciones y de las emisiones atmosféricas.

Para evitar y minimizar estos, se tienen medidas de prevención, mitigación y monitoreo durante las obras, como:

- control de las actividades de movimiento de tierras, prevención y control de procesos erosivos;
- tratamiento de efluentes en fosas sépticas, gestión de residuos sólidos y de materiales peligrosos;
- monitoreo de emisiones de los vehículos y maquinaria de construcción (visual);
- monitoreo de emisiones atmosféricas de fuentes fijas;
- supervisión de obras.

Operación: aumento del consumo de agua del río Paraguay y potencial contaminación por el vertido de aguas residuales tratadas, además del deterioro de la calidad del aire por las emisiones de los equipos de la Planta.

Se estima un consumo neto de 165.4 m3/h equivalente al 0.008% del caudal mínimo del río. Además, el efluente a retornar al río será tratado en una Estación de Tratamiento de Aguas Residuales, retornando agua con mejor calidad que la existente en el río.
Se monitoreará el caudal de agua utilizado, la calidad de los efluentes y la calidad del agua del río para asegurar el cumplimiento de las normas nacionales e internacionales ambientales.

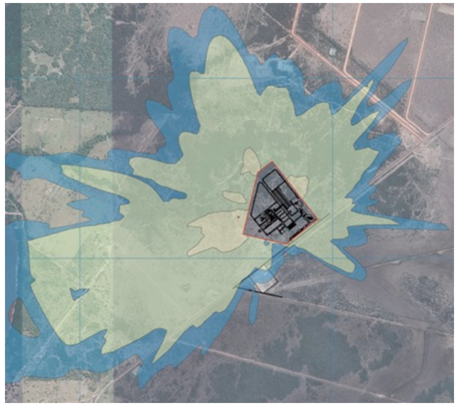
Medio Físico

Identification of Main Impacts

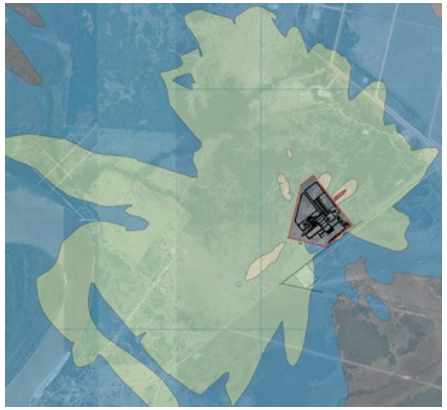
Medio Físico

Los resultados de la modelización de dispersión de contaminantes atmosféricos muestran que las emisiones de CO, NO_2 y NH_3 están muy por debajo de los límites fijados por la legislación paraguaya e internacional. Sólo en el caso del material particulado, cuando se consideran los valores diarios de calidad objetivo propuestos por la CFI, se puede observar que la calidad actual (línea de base) influye en el nivel de cumplimiento futuro.

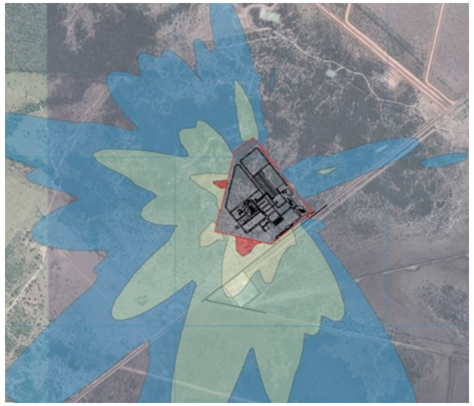
Mapas de isoconcentraciónes de contaminantes



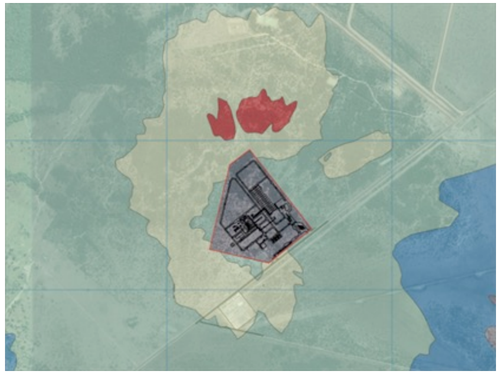
CO – operación de 24 h



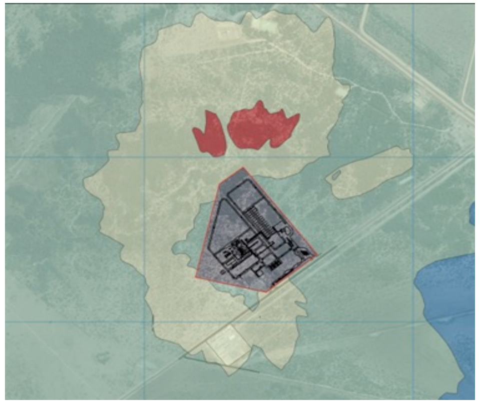
NO_2 – operación de 24 h



NH_3 – operación de 1 h



PM10 – operación de 24 h



PM2.5 – operación de 24 h

- Medidas de gestión y monitoreo durante la operación:
  - monitoreo del efluente tratado en la Estación de Tratamiento de Aguas Residuales – ETAR de la Planta y monitoreo de la calidad del agua y caudales;
  - especificaciones de diseño de los equipos de la planta para cumplir con los límites establecidos por la legislación paraguaya e internacional;
  - monitoreo de emisiones atmosféricas y de la calidad del aire.

Identification of Main Impacts

Medio Físico

Es en el Medio Físico donde se espera el mayor impacto positivo del Proyecto, que es la Reducción de las emisiones de Gases de Efecto Invernadero (GEI) y de la huella de carbono.

Considerando los totales de t CO_2-eq/año para la producción y distribución del fertilizante CAN estimados para la Planta verde de ATOME y para una Planta gris, se observa que el total de la verde corresponde al 37.7% del valor total en la gris.

Teniendo en cuenta estas cifras, se observa que el proyecto de ATOME tiene una capacidad de desplazamiento de alrededor de 525,000 t CO_2-eq/año, con un total de 13,125,000 t CO_2-eq si se tiene en cuenta la vida útil del Proyecto de 25 años.

Identification of Main Impacts

Pérdida de vegetación.

Previsión de desbroce de:

- 29.85 ha para la instalación de la Planta: 6.14 ha son bosques y 23.7 ha son sabanas;
- 0.07 ha de sabanas para implantación de la LT;
- 0.69 ha para la instalación de las tuberías subterráneas de agua y efluentes: 0.56 ha de sabanas y 0.13 ha de bosques.

Medidas de mitigación y monitoreo durante las obras:

- ❖ control de actividades de supresión de vegetación;
- ❖ rescate de germoplasma (semillas y plántulas);
- ❖ recuperación de áreas degradadas por las obras;
- ❖ supervisión de las actividades;
- ❖ capacitación y educación ambiental de trabajadores;
- ❖ monitoreo de la flora.

Medio Biótico

Medidas de compensación:

- ❖ Plan de Acción de Biodiversidad (PAB): compensación ambiental mediante conservación de bosques, compensación ambiental mediante adquisición de Certificados de Servicios Ambientales y compensación ambiental por árboles taladas.

Pérdida de hábitats de la fauna.

- ❖ Ahuyentamiento previo y rescate de fauna durante la fase de construcción.
- ❖ monitoreo de la fauna.

Identification of Main Impacts

Medio Socioeconómico

Construcción: impactos temporales, incluyendo molestias causadas por las actividades de construcción y aumento de tráfico especialmente durante la entrada y salida de camiones y autobuses de trabajadores.

- Medidas de prevención, mitigación y monitoreo durante las obras:
  - ❖ control y monitoreo de emisiones atmosféricas;
  - ❖ control y monitoreo de ruido y vibraciones;
  - ❖ mantenimiento de equipos;
  - ❖ supervisión de obras;
  - ❖ gestión del tráfico de construcción: capacitación de conductores, cumplimiento de límites de velocidad, elección de las mejores rutas;
  - ❖ código de conducta de trabajadores;
  - ❖ mecanismo de manejo de reclamos.

Impacto positivo: creación de empleos durante las obras. Se prevé la contratación de 461 trabajadores directos para la construcción y montaje de la Planta (en el pico) y otros cerca de 30 trabajadores para la LT.

- ❖ medidas de potenciación de la contratación de trabajadores locales;
- ❖ capacitación laboral.

Riesgos de accidentes con trabajadores durante la construcción (.

- ❖ Programa de Salud y Seguridad Laboral en la Fase de Construcción (procedimientos de trabajo seguro, supervisión de salud y seguridad, capacitación en salud y seguridad, gestión de la salud del trabajador);
- ❖ Plan de Acción de Emergencia para incendios / explosiones durante la construcción.

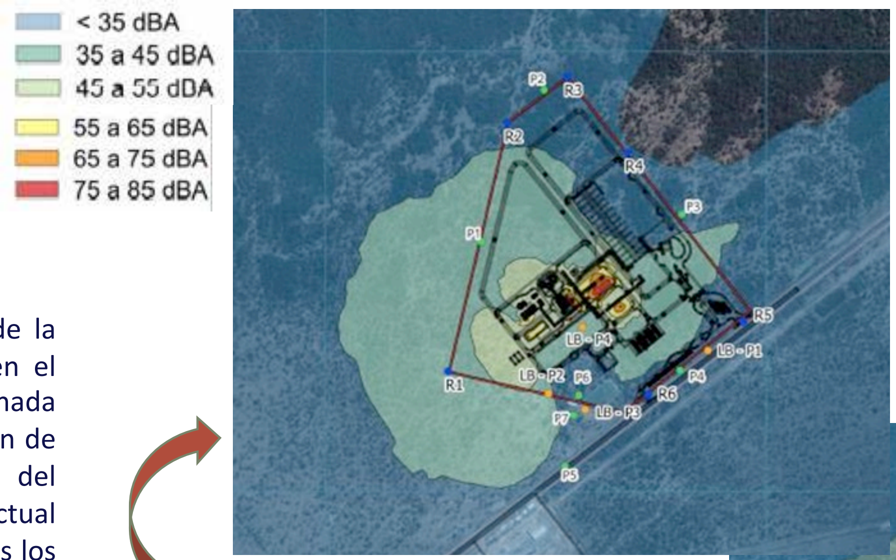
Identification of Main Impacts

Medio Socioeconómico

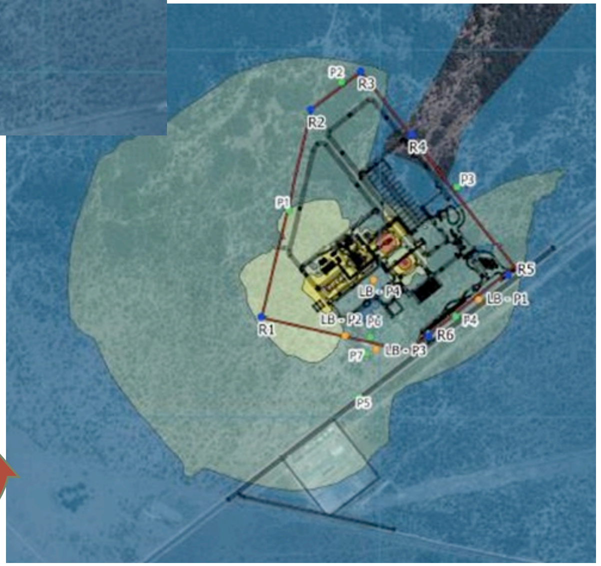
Operación: molestias por ruido en la fase de operación.

Conclusiones de la modelización: la futura operación de la Planta no generará un impacto negativo significativo en el entorno. La calidad acústica continuará siendo determinada por la condición actual (de línea de base). La contribución de nivel de presión sonora producto del funcionamiento del proyecto es sustancialmente menor a la condición actual (línea de base), con valores de menos de 10 dBA en todos los receptores puntuales evaluados.

- Medidas de prevención, mitigación y monitoreo:
  - ❖ especificaciones de diseño de los equipos de la planta para cumplir con los límites establecidos por la legislación paraguaya e internacional;
  - ❖ monitoreo de ruido en la operación.
  - ❖ mecanismo de manejo de reclamos.



Escenario 1 - ruido exclusivo de la operación del Proyecto basándose en las especificaciones de emisión sonora de los equipos (funcionamiento 24 horas y simultáneo).



Escenario 2 - escenario anterior sumado a las medidas de mitigación del impacto de ruido definidas en el diseño de ingeniería de la Planta.

Modelización del ruido de la Planta utilizando el modelo CadnaA.

Identification of Main Impacts

Medio Socioeconómico

Operación: molestias por olores en la fase de operación, causados por el funcionamiento de la Planta de Tratamiento de Aguas Residuales (ETAR), Planta de síntesis de NH_3 y Tanque principal de NH_3.

- Medidas de prevención, mitigación y monitoreo:
  - medidas de control de emisiones atmosféricas;
  - especificaciones de diseño de los equipos de la planta para cumplir con los límites establecidos por la legislación paraguaya e internacional;
  - mecanismo de manejo de reclamos.

Impacto positivo: creación de empleos durante la operación. Se prevé la contratación de 240 puestos directos, de los cuales 195 son puestos fijos y 45 son temporales. Además, se generarán unos 874 puestos de trabajo indirectos.

- medidas de potenciación de la contratación de trabajadores locales;
- capacitación laboral.

Riesgos de accidentes con trabajadores durante la operación: incendio, explosión, fuga de amoníaco, ácido nítrico y nitrato de amonio.

- Programa de Salud y Seguridad Laboral en la Fase de Operación (procedimientos de trabajo seguro, supervisión de salud y seguridad, capacitación en salud y seguridad, gestión de la salud del trabajador);
- Plan de Acción de Emergencia en caso de explosión;
- Plan de Acción de Emergencia en caso de incendios;
- Plan de Acción de Emergencia en caso de fugas de sustancias.

Environmental and Social Management Plan

- **Programa de Control Ambiental de la Construcción**
  - ✓ Medidas de gestión de:
    - ❖ actividades de movimiento de tierras
    - ❖ actividades de supresión de vegetación
    - ❖ agua y efluentes
    - ❖ emisiones atmosféricas
    - ❖ residuos sólidos
    - ❖ materiales peligrosos
    - ❖ ruido y vibraciones
    - ❖ campamento de construcción
  - ✓ Medidas de monitoreo de:
    - ❖ emisiones atmosféricas
    - ❖ ruido
  - ✓ Recuperación de áreas degradadas por las obras

- **Programa de Gestión Ambiental**
  - ✓ Supervisión de la construcción
  - ✓ Coordinación de Programas del PGAS
  - ✓ Promoción y desarrollo de proveedores locales
  - ✓ Gestión de las emisiones de GEI
  - ✓ Negociación y adquisición de tierras

- **Programa de Participación de las Partes Interesadas**
  - ✓ Consulta pública
  - ✓ Divulgación continua de información a las partes interesadas
  - ✓ Mecanismo de gestión de quejas, consultas y sugerencias

- **Programa de Salud y Seguridad Laboral**
  - ✓ Procedimientos de Trabajo Seguro
  - ✓ Capacitación en seguridad ocupacional
  - ✓ Supervisión de salud y seguridad
  - ✓ Gestión de salud del trabajador

- **Programa de Gestión del Trabajo y Condiciones Laborales**
  - ✓ Política de Recursos Humanos
  - ✓ Contratación y capacitación laboral
  - ✓ Condiciones de trabajo y de empleo
  - ✓ Mecanismo de manejo de reclamos para trabajadores
  - ✓ Código de conducta para trabajadores
  - ✓ Educación ambiental y Social de trabajadores

- **Programa de Respuesta a Emergencias para la Fase de Construcción**
  - ✓ Planes de Acción de Emergencia para casos de derrame de productos peligrosos; incendios / explosiones; eventos extremos, como tormentas severas y sequías

Environmental and Social Management Plan

- **Programa de Prevención de Impactos en Fauna y Flora**
  - ✓ Rescate de germoplasma
  - ✓ Ahuyentamiento previo y rescate de fauna

- **Plan de Acción de Biodiversidad (PAB)**
  - ✓ Subprograma de Conservación de Biodiversidad
    - ❖ Monitoreo de la fauna y flora
    - ❖ Compensación ambiental mediante conservación de bosques
    - ❖ Compensación ambiental mediante adquisición de Certificados de Servicios Ambientales
    - ❖ Compensación ambiental por árboles taladas

- **Programa de Respuesta a Emergencias para la Fase de Operación**
  - ✓ Planes de Acción de Emergencia para casos de explosión física / incendios / fugas de gases / derrames de productos peligrosos / accidentes con barcazas eventos extremos, como tormentas severas y sequías

- **Programa de Conservación del Patrimonio Arqueológico y Cultural del ADA**
  - ✓ Acompañamiento arqueológico
  - ✓ Procedimiento en caso de hallazgos fortuitos

- **Programa de Gestión Ambiental y Social de la Fase Operación**
  - ✓ Supervisión del cumplimiento de medidas ambientales y sociales de la fase de operación
  - ✓ Capacitación ambiental y social del equipo de O&M
  - ✓ Gestión de residuos sólidos
  - ✓ Medidas de monitoreo de:
    - ❖ calidad del agua
    - ❖ ruido
    - ❖ calidad del aire
    - ❖ olores
  - ✓ Supervisión de empresas contratadas
  - ✓ Mantenimiento de la franja de servidumbre

- **Programa de Gestión del Transporte en la Fase de Operación**
  - ✓ Mantenimiento rutinario
  - ✓ Inspección de las carreteras e implantación de mejoras

Conclusions

- El EIAS desarrolló una amplia **línea de base** del área de influencia del proyecto.
- Se identificaron algunos impactos de la fase de construcción, que serán **temporales y podrán prevenirse y mitigarse** con el amplio conjunto de medidas propuestas en el PGAS ya descrito, y que serán adoptadas por los Contratistas como parte de sus contratos y supervisadas por Atome.
- En la operación, los principales impactos negativos están relacionados con el ruido y emisiones atmosféricas de la Planta, la captación de agua y la descarga de efluentes tratados en el río Paraguay, **todos considerados de baja magnitud con la aplicación de las medidas de prevención incorporadas en las tecnologías, medidas de mitigación y control**. Como ya se mencionó, la especificación de diseño de los equipos ya tiene en cuenta los niveles de ruido y emisiones para cumplir con la legislación, y también está previsto el monitoreo. En cuanto al agua, la captación será irrisoria en relación con el caudal del río, y el tratamiento de los efluentes garantizará el vertido al río de un agua tratada que cumpla las normas de la legislación nacional e internacional.
- Los riesgos de **explosión, incendio y fugas de contaminantes** estarán restrictos a las instalaciones de la Planta, previéndose Planes de Acción de Emergencia para todos estos escenarios de emergencia.
- Como **impactos positivos**, se puede mencionar la **generación de empleos** en las fases de construcción y operación y la **dinamización de la economía**, especialmente de Villeta.
- El principal impacto positivo del Proyecto es la **reducción de las emisiones de gases de efecto invernadero – GEI y de la huella de carbono** de la cadena de producción agrícola y de alimentos.

Public Consultation

Gracias!

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Annex 5 – Minutes of the Public Consultation

Minutes of the Public Consultation of the Project "Free Trade Zone and Hydrogen, Ammonia and Green Fertilizer Production Plant" of ATOME Paraguay S.A.

Date: 13/12/2023
Time: 6 p.m.
Location: Villeta, Paraguay

The event kicked off at 6:07 pm.

Viviana Brun, environmental coordinator of Atome Paraguay S.A., welcomed everyone to the event, explained the dynamics of the meeting and the objectives and expected results, highlighting that the contributions of those present will be taken into account in the final version of the ESIA.

Next, Juan Pablo Nogues, Project Manager of Atome Paraguay, thanked those present, and continued to present information about the Atome company and details of the Project, including the location and its components, information about hydrogen, ammonia and green fertilizer and their advantages, the main and auxiliary facilities of the Plant, the operation and maintenance aspects and the environmental controls that will be adopted to avoid and minimize impacts.

Juan Pablo then gave the floor to Bruno Michelotto, consultant and specialist in Physical Environment at JGP Consultoria, the Brazilian company responsible for the preparation of the ESIA, to continue the presentation, summarizing the main points of the studies.

Bruno began the presentation with the studies of locational and technological alternatives carried out for the Plant, the power transmission line (LT) and the water and effluent pipes, and that the objectives of these studies were to achieve a Project with the best possible technology and to seek the most suitable location for its construction and operation. in order to cause the least possible environmental and social impact.

He also presented succinct information on the baseline made for the areas of indirect and direct influence and the area directly affected by the Project. He explained the studies and data collection on climate, water resources, geology, geomorphology and soils, environmental noise and air quality, flora and fauna, and socioeconomic data of the municipality of Villeta and the area surrounding the Plant land, through the investigation of secondary data in official sources and fieldwork with surveys and interviews.

Bruno then explained the methodology used to identify and evaluate the environmental and social impacts of the Project and the main impacts and risks evaluated for the Project in its construction and operation phases, highlighting that the main ones will be of low magnitude due to the technology adopted for the Plant and the environmental controls that will be applied by the operation and maintenance company to be contracted by Atome. He also described the main measures envisaged in the Environmental and Social Management Plan (ESMP) to prevent, mitigate, control and compensate for the impacts and risks identified and evaluated. The ESMP includes a set of 12 Programs, which Bruno briefly presented below, highlighting that the measures established in the Programs will be implemented during the construction and operation of the Project as a commitment by Atome to achieve a Project with minimal environmental and social impacts.

Once the presentation was over, Juan Pablo took the floor again and opened the question/comment and answer session.

Question 1:

Ms. María Britez, from the Ypeka'e Community, began her question by commenting on the importance of fishing for the community, and that she feared the impact of the Project on the quantity and quality of water in the Paraguay River, considering the other current and future uses of the river, and the consequences of this cumulative impact on the community's fishing activity.

Answer:

The answer was given by Bruno Michelotto, who mentioned that JGP has conducted a cumulative impact study, which was not on the slides, but is listed in the ESIA. The study found that the magnitude of the impact of the Atome Project on water quality and quantity is much smaller than the impact of the other planned projects and those already occurring in the area of influence. According to him, the cumulative effect of the projects is important, but the expected effect of the Atome Plant is very, very low. He spoke about the wastewater treatment planned at the Plant, which will comply with Paraguayan and international legislation.

Viviana, from Atome, added that, in addition to mitigation and prevention measures, it is important to know that compliance with Paraguayan and international legislation has already been taken into account from the design stage, so that the technologies chosen for the Project are the best in terms of prevention and mitigation of impacts. Thus, it is expected that what is discharged into the river will be of better quality than the water we have today.

Question 2:

Mr. Julio Gamarra, from the Municipal Council of Villeta - Councilor, mentioned that the importance of Paraguay is well known due to the availability of energy and fresh water. He said that this type of project posed a great risk of reducing water flow and impacting water quality. He asked if a project could be rejected by the environmental agency if the impacts were high. It is also concerned about the cumulative effect of the Atome Project with those already in place and the effect over time.
Another positive comment by Mr Julio concerns the jobs that will be created.

Answer:

Bruno Michelotto began his response by mentioning that the study could indeed have a negative conclusion on the part of the consultancy and the environmental agency, and he recounted an example that occurred in Brazil. However, in the case of Atome, the ESIA team is very confident in the impacts that have been identified, the proposed control measures, and the capacity to support the environment. As for the long-term effect, 20 years from now, for example, he assumed that there is no way to know if the environment will be able to withstand it, among other things because it will depend on future projects that are approved in the area of influence.

Juan Pablo, from Atome, complemented the answer by giving an idea of the volume of water that the Plant will capture and the minimum percentage it represents in relation to the flow of the river. He also stressed that Atome will have to comply with national and international legislation. In the event of a drought, you will have to respect the permitted collection volumes, even if they are lower than the needs of the Plant. Juan Pablo mentioned that today they do not need to pay the fee.

Comment 3:

Another representative of the Ypeka'e Community mentioned that there will be two associations affected by the Project and the residents are very concerned because fishing is the only livelihood of the families and they are not included in the company's program.

Answer:

Bruno Michelotto gave the answer, mentioning that the Project is in a very early phase. A stakeholder relations program is planned, and the Ypeka'e community will be one of the main focuses of social communication to be carried out as part of this program, as it is the main community located downstream of the project. Communication has already begun with the ESIA social surveys, but will intensify during construction and operation.

They may not have been seen in the presentation (in fact, the community is mentioned in the Nearby Communities slide), but they are in the ESIA.

Viviana stressed that the stakeholder relations program is one of the most important for Atome and will begin immediately, including not only the Ypeka'e community, but also residents neighboring the Plant site and other stakeholders. He insisted once again that the project also includes effluent and water quality control measures, and that the community can rest assured that the company will share the results of the measures with the community.

Question 4:

A representative of the Center for Heñoi Studies asked what the implications of the name Free Trade Zone are.

Answer:

Juan Pablo, from Atome, explained that it was mainly a tax issue. Free Trade Zone is established by decree and has tax benefits for the purchase of equipment and services during the works. He also explained the benefits of a free zone that can be returned to the country.

Comment 5:

Mr. Julio Gamarra, from Concejal, continuing with the issue of taxes, commented that even though it is a free zone, Villeta has a municipal tax on construction.

Comment 6:

One participant commented that mitigation measures are super important and need to be worked on very carefully. The measures must be explained in detail, mainly the treatment of water for return to the river and for cases of leakage of by-products and products, which are very volatile.

Answer:

Juan Pablo explained that they are doing everything very carefully, both the design and the preparation of environmental and social control measures. No one but Atome is interested in the project being as good as possible from a socio-environmental and economic point of view. They are using all the technologies and based on international standards. And you can go into more detail about the measurements and design another time.

Question 7:

One participant asked about the impact on air quality. It called for a better explanation of the modelling carried out and the expected impacts. He also asked if JGP has experience in this type of H2 project, and if it is in a position to know and predict the impacts and risks to the population.

Answer:

Bruno Michelotto replied that, knowing that the Project could emit pollutants, an atmospheric dispersion modelling was carried out, based on the plant's emissions and climatic conditions. He explained that in Paraguay there is a preferential natural path of the wind through the valley. The modelling showed that there is a risk of impact on air quality, but that it will be of low magnitude. He explained in much more detail the dispersal conditions in winter and how this can influence the dispersion of pollutants, explaining that this would be the worst period. During the summer, the risk of impact on air quality is lower.

He mentioned again what Viviana had already said, that the technology adopted and designed for the Plant aimed to use equipment that emitted the lowest levels of pollutants into the atmosphere to comply with national and international legislation.

He mentioned that there may be periods of critical events, such as droughts. However, the Project provides for air quality monitoring, which will indicate the eventual need to intensify mitigation measures.

Bruno reviewed JGP's experience, of the different projects that the company has already carried out, but that the modelling of an H2 plant is in fact the first to be carried out.
Juan Pablo mentioned that this plant is the first in Latin America and that it will be installed in Paraguay mainly because the country has renewable energy. He mentioned the gases that will be vented, mainly oxygen, which is not polluting. And that there will be emissions of NOx, SO2 and particulate matter, but they will be minimal, and mitigation measures are planned. Viviana re-emphasized the adoption of technology to comply with international measures, including those of the WHO, to guarantee the integrity of the population's health.

Comment 8:

Another representative of the Villeta Council said that she had many questions that would be impossible to answer in the two-hour duration of the Public Consultation. That they should form a working group to discuss the Project. That the $_{H2}$ production project has been presented in the Consultation as a very nice project that uses renewable energy, but that it does not know all the uses that H2 can have and that it is a highly explosive product. That in Villeta there are industries that use H2 and have a product storage system in which a lot of investment is made to comply with safety standards. He also highlighted the risks and problems of liquid ammonia. The third product, fertilizer, doesn't worry him.

He wants to dig deeper into these risks to the community. He says that the company should sit down with the municipality to look at the expected impacts and study the measures together, especially to provide previous experiences to improve the project. He believes that it is good that Villeta continues to grow, but that there must be a balance between economic growth and the preservation of the environment.

He praised the initiative to carry out the Public Consultation and to make a contact number and an email available to the population.

Answer:

Juan Pablo de Atome thanked them and said they would organize a more technical presentation for the Councilman.

He clarified that

That the final product of the plant is fertilizer, which is very stable and everyone knows how to handle.

they will not store H2 or NH3, and that these hazardous products will go directly through the production chain to make fertilizer. The plant will link all production chains.

Comment 9:

Mr. Angel, from the Heñoi Study Center, mentioned that it has been pointed out during the presentation that the Project site has no neighbors, that it is a place where there is nothing around. However, in front of the Buey Rodeo substation, a mine is being built, and next to the project, the Omega Green biofuels plant is going to be built. All of these projects together will have impacts. He also mentioned that the wetlands that occur in the area where the projects will be built are the ecosystem that captures the most carbon. That it has been said that the Atome Project will reduce the carbon footprint, but that this is not credible, since the construction of large factories in a place where it will be necessary to remove native vegetation and impact wetlands, should result in an increase and not a reduction in the carbon footprint.

Answer:

Bruno responded by highlighting Mr. Angel's observation on the characteristics of wetlands and their importance to the carbon chain. However, he clarified that the Atome project does not foresee any intervention in this type of land.

He confirmed that native vegetation will be cut down for the Project and that carbon will be released. However, there will be a compensation program that includes the planting of native vegetation.

He again mentioned the studies of alternatives that had been carried out. And the compensatory measures envisaged for impacts that cannot be avoided, such as the removal of vegetation. And that based on all of the above, the reduction of the Project's carbon footprint in the long term is positive.

Juan Pablo complemented by giving more details about the accounts of the carbon balance and highlighting that the calculations are not made for the project area, but in a broader way, considering the entire chain.

Viviana also pointed out that there is compensation for the environmental services that the Project will fulfill, and based on this, they will have to compensate even more than the impact. And what is affected by forest must be compensated with forest; What is affected by Savannah must be compensated with Savannah. In addition, Villeta is demanding a compensatory planting for the felled trees. They will comply with everything that the city council asks of them. He also mentioned the measures to repel and rescue fauna and rescue germplasm and that the aforementioned measures are only part of the set of measures that Atome will implement not only to comply with Paraguayan legislation, but also with international legislation.

Bruno responded again, emphasizing that a cumulative impact study has been conducted for the Project and that it has been evaluated and approved by the top cumulative impact specialist at present. There is a cumulative impact management program that provides for collective management of these impacts by all Project promoters.

Comment 10:

Once again, Mr. Julio Gamarra, from Councillor, also insisted on the importance of wetlands, and that he is also concerned that the Project will exploit groundwater.

Answer:

He was told that the project will only use water from the Paraguay River. They will not collect groundwater. The quality of the groundwater from an existing well on the Plant's land has been studied, but it is brackish, which would be harmful to the machines and would require a very sophisticated treatment.

Comment 11:

Despite having her question answered, Ms. Maria Britez, from the Ypeka'e Community, again expressed that the fishermen of Ypeka'e are very concerned and asked when the project is expected to start impacting the water and fish.

Answer:

Bruno responded again by sizing the flow that the Project will capture in comparison to the flow of the river. And that this represents a low risk that the Project will affect the river in terms of flow reduction, water pollution and impact on fish.

Juan Pablo complemented by clarifying that the project will not begin to pollute the water. That measures and controls are being planned so that the treated effluent returned to the river is even better than the water collected. He also explained that the treated effluent will be discharged into the river at a point near the catchment, through a subfluvial pipe, which will discharge the effluent in a place away from the shore.

This again explains that the project is not expected to have a significant impact on the quantity and quality of water or fish. He again explained how the water will be captured and how much will be collected, and that the treated wastewater will be returned near the catchment, which means that the water will be collected.

Regarding the start date of the Project, he explained that it is not yet defined. That the company expects that work can begin in the first months of 2024, that the construction will last 2 years and therefore the operation is expected for 2026.

Viviana added that all stakeholders interested in the project will be informed of the planned dates. The communication strategy must ensure the transparency of the Project.

Comment 12:

Another participant mentioned the time it takes to carry out and see the results of renewable resource recovery measures, such as reforestation, flora and fauna recovery, wastewater treatment, and water quality monitoring. He says this based on the experience they have of the construction of the hydroelectric plant, since the works are carried out very quickly compared to the time needed for reforestation and other recovery measures.

The concern is because there is a population that depends on the resource, and the water is already heavily polluted and temperatures are very high. That is why they have to continue monitoring to see if everything is being executed as planned and if the measures applied are having an effect.

Question 13:

One participant commented on the more than 30 years of experience Bruno had mentioned JGP had. He asked what environmental problems the company had in its different projects over the past 30 years and whether the company had received any major wake-up calls from the environmental authorities in that time.

Answer:

Bruno mentioned that the company has seen numerous problems and gave as an example the Belo Monte hydroelectric project, which has some threatened fish species that exist only there. That we have already seen the sale of rare species. However, JGP is a consulting company that does not carry out the work, it is not the cause of the impact. It is a company that is contracted to evaluate the impacts of projects, advising private, public or intergovernmental clients on how to carry out projects in the best possible way, based on the best performance standards.

Comment 14:

Another participant mentioned that the population's fear is the added impacts, taking into account other industries. That the problem is not the Atome project, but the combined effect of all the projects. However, it trusts that social responsibility measures will be applied during the execution and operation to communicate, involve communities and reduce impacts.

Answer:

Bruno agreed and stressed that this is the case. That is the objective of this Public Consultation. For problems to be mentioned and discussed, and for solutions to be discussed together.

Comment 15:

Another participant mentioned that he was concerned about the issue of public health. The Project should provide for follow-up in this regard, as many outsiders are likely to be interested in the Project. He also mentioned the need to provide clear information to the population.

Answer:

Juan Pablo responded, pointing out that Atome has made available contact channels (email and phone) for doubts and queries, and showed them in the ppt presentation that was still on the big screen. He clarified that the work will not begin tomorrow and that Atome has a direct line to the municipality and the Councilor, and that they will continue to meet to answer any questions and answer them as far as possible. And that, if another hearing is necessary, they can hold it.

Comment 16:

Another participant again congratulated the company for carrying out the public consultation and opening the communication channel for the population to express their concerns. He said it was good to know the commitments that Atome was going to make. He thanked the company for getting the community involved now.

Answer:

Viviana responded, highlighting that the company has an Environmental, Social and Health and Safety Management System, which must prepare monthly and quarterly reports on the implementation of the measures, and that within a ESMP Program it is planned to share with the municipality a quarterly bulletin to report on the progress and results of the application of the measures. including a summary of the monitoring to be carried out. This will give people peace of mind, who will be able to accompany if the company is meeting its commitments.

Comment 17:

Another participant mentioned that during the Consultation there was a lot of talk that the project would comply with international standards, but that municipal ordinances would have to be consulted. That there is one that deals with the issue of odour control, an issue that is not dealt with in national legislation.

He added by congratulating the company for carrying out the consultation and that he hopes that this practice will be applied to all projects, allowing the population to get to know them and express their concerns.

Comment 18:

Another participant also congratulated the company on the hearing. However, she agreed with the other Ms. that another public consultation should be held to deal with the issues more calmly. He mentioned again that the flow that will be extracted for the Project will be small, but that there are large rice companies in the city and that the sum of water uses will be important. He also mentioned that there are nearby communities, Ypeka'e and Santa Rosa, where several of those present at the hearing were from, although the studies had not mentioned them. Finally, he said that Councilman participants should discuss whether to approve or reject the project.

Answer:

Bruno mentioned that the communities had been identified in the studies. They may not have been included in the submission, but they are in the ESIA, which will be made public.
That this meeting is being recorded in minutes and on a recording, and that all the information discussed today will be incorporated into the study. This consultation is one of the tools to develop the project in the best possible way.

Juan Pablo said he would be available to continue discussing questions and comments in private. As there were no further questions or comments, he adjourned the meeting.

The consultation ended at 8:07 pm.

Annex 14 – Risk Area Figures

Figure 6.4.1.3.b-1
Flash fire *hazard areas* in the H2 Separators (SEP1, SEP2, SEP3 and SEP4) of the Electrolysis Building

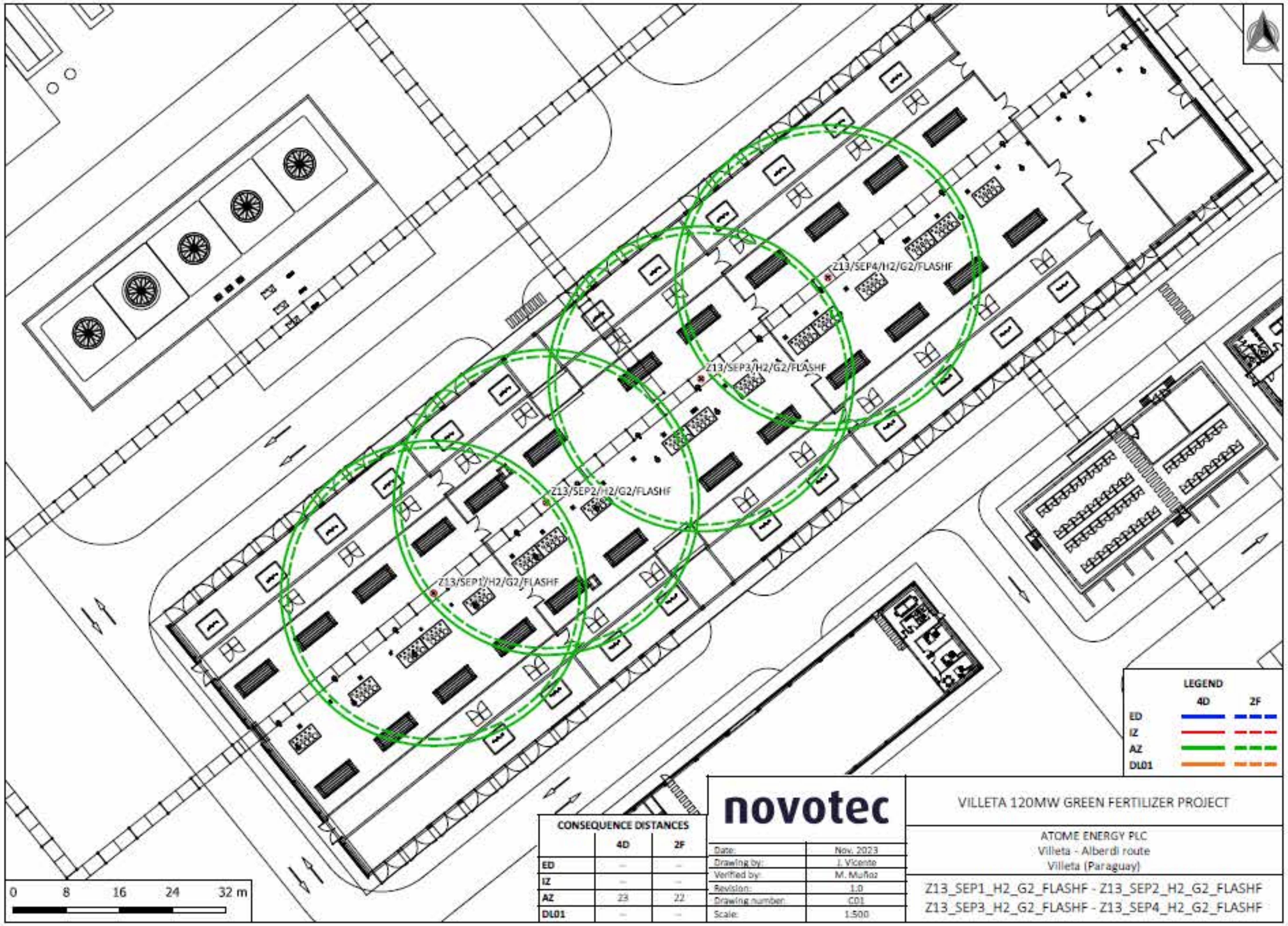


Figure 6.4.1.3.b-2
Physical Explosion Hazard Areas (ECVs) in the H2 Separators (SEP1, SEP2, SEP3 and SEP4) of the Electrolysis Building

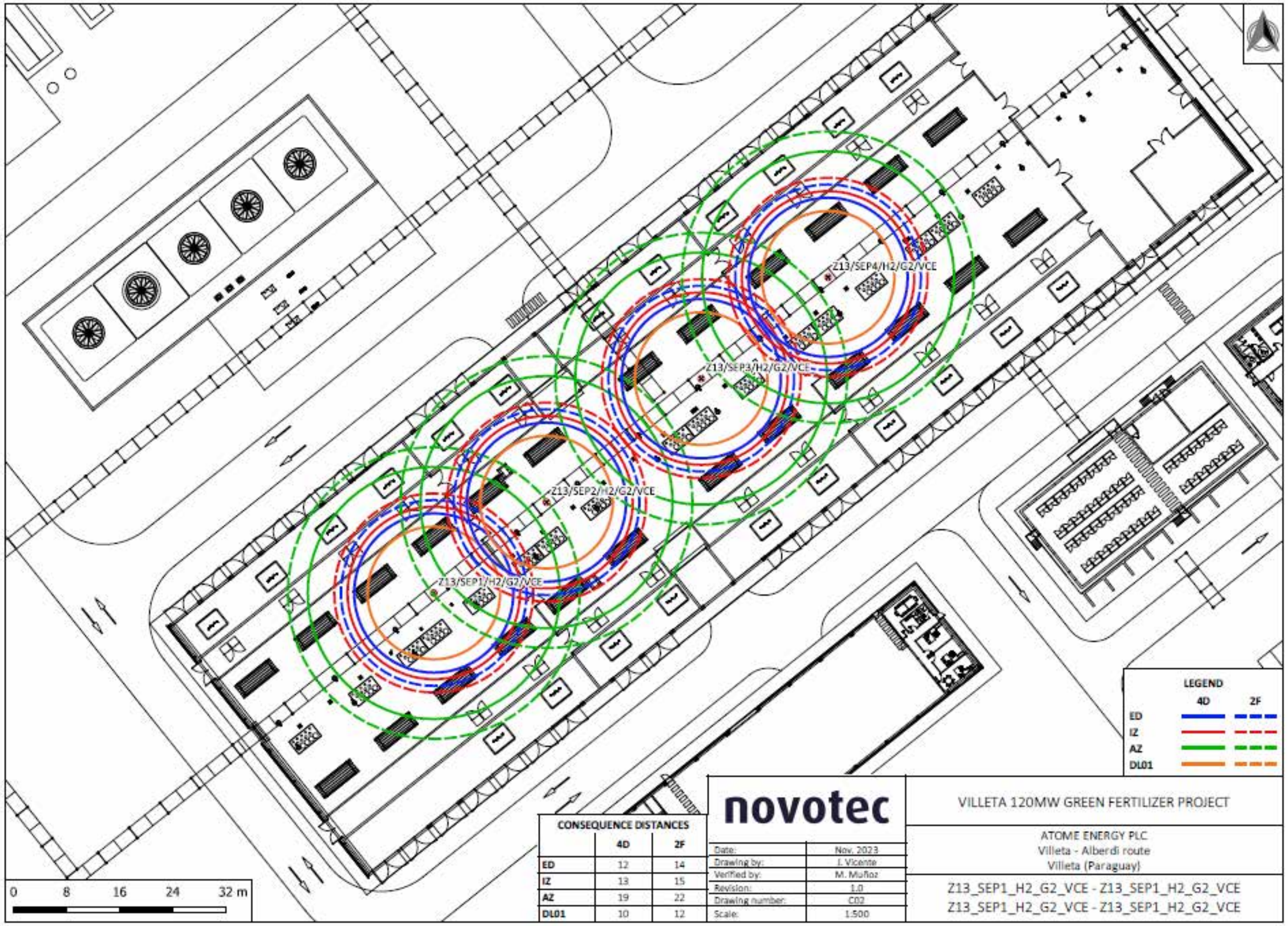


Figure 6.4.1.3.b-3
Jet Fire *Risk Areas* in H2 Separators (SEP1, SEP2, SEP3 and SEP4) of the Electrolysis Building

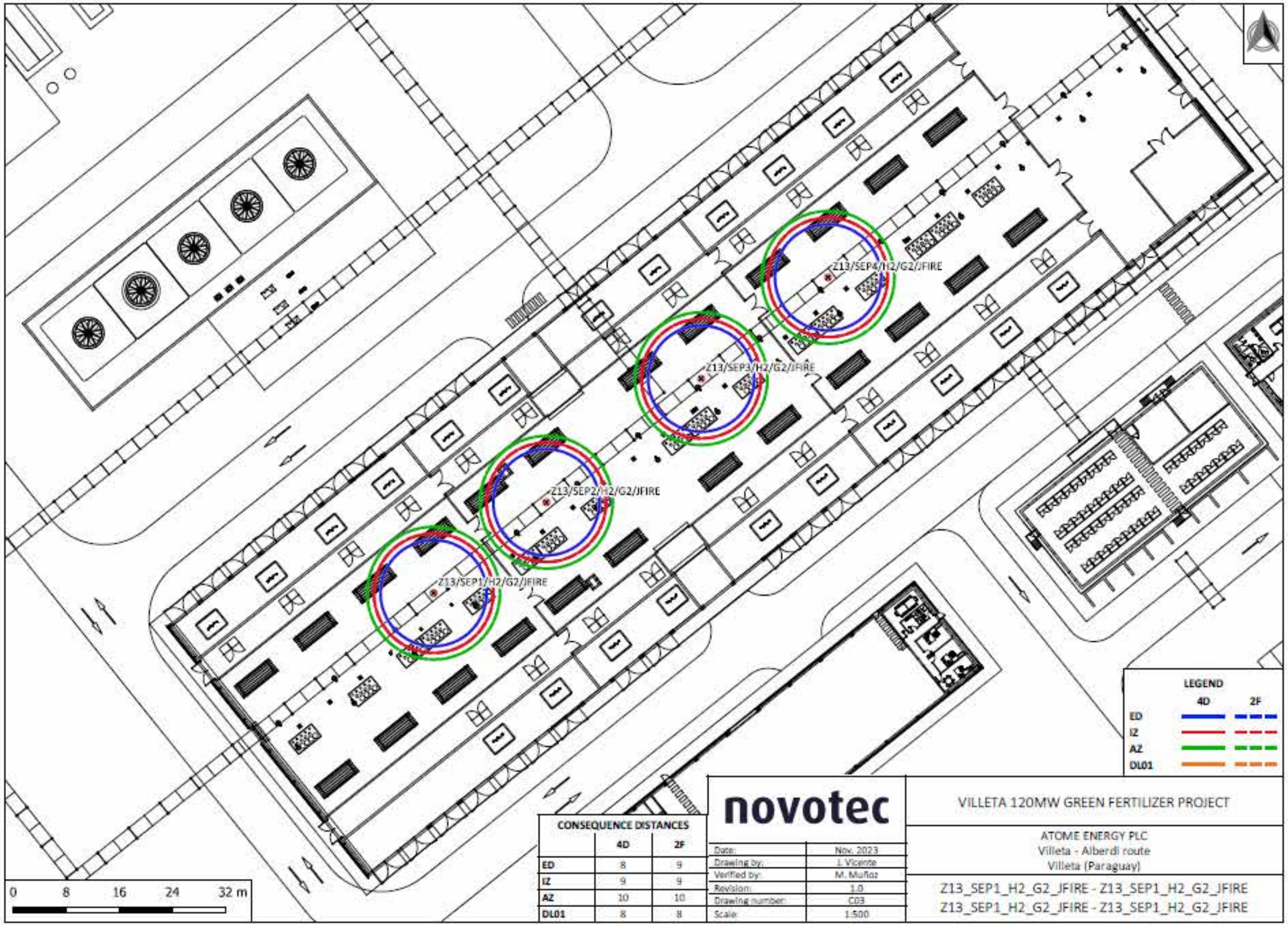
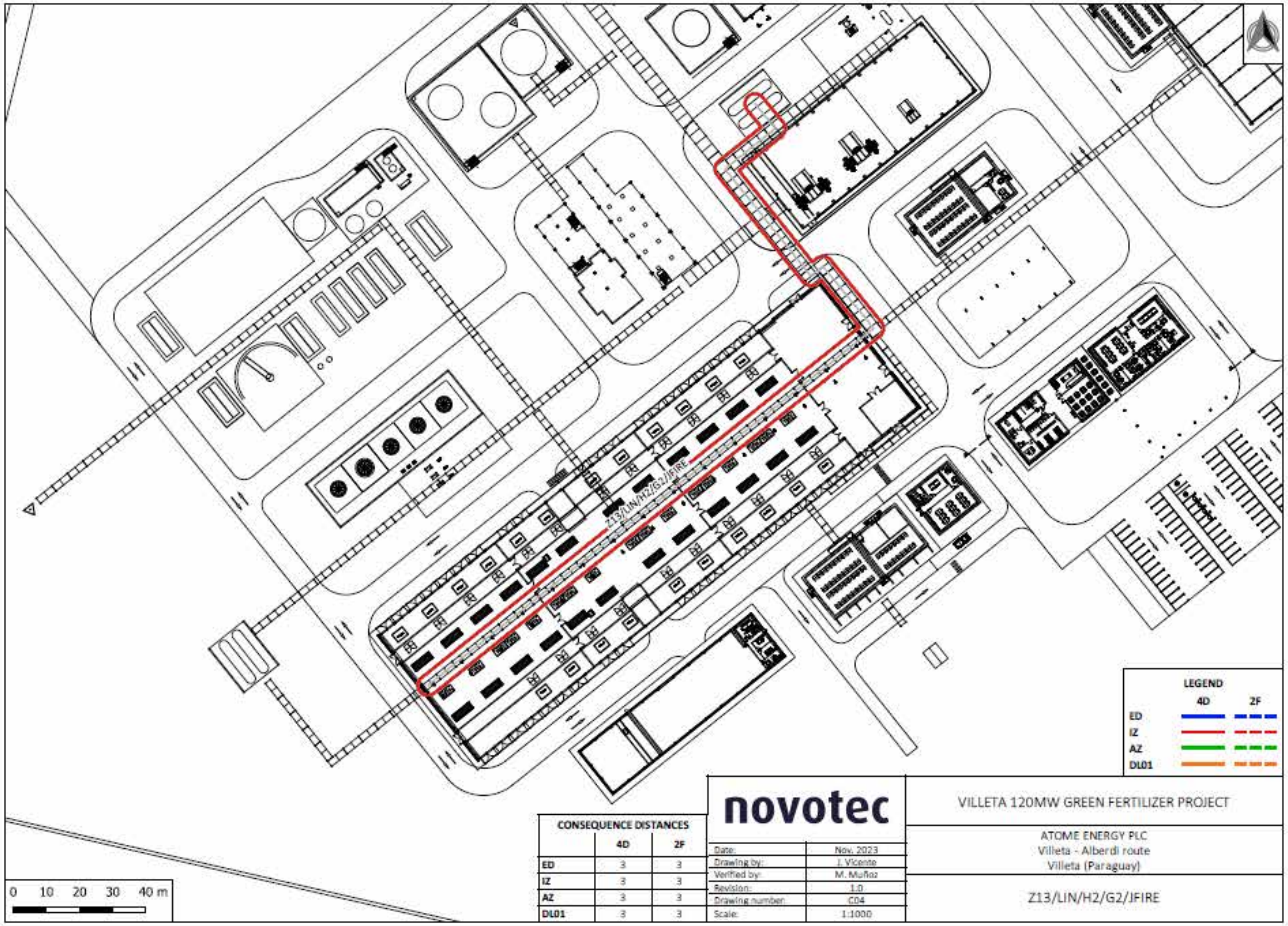


Figure 6.4.1.3.b-4
Jet *fire* on the line of the Electrolysis Building



CONSEQUENCE DISTANCES	4D	2F
ED	3	3
IZ	3	3
AZ	3	3
DL01	3	3

Figure 6.4.1.3.b-5
Physical Explosion (VCE) on the Line of the Electrolysis Building

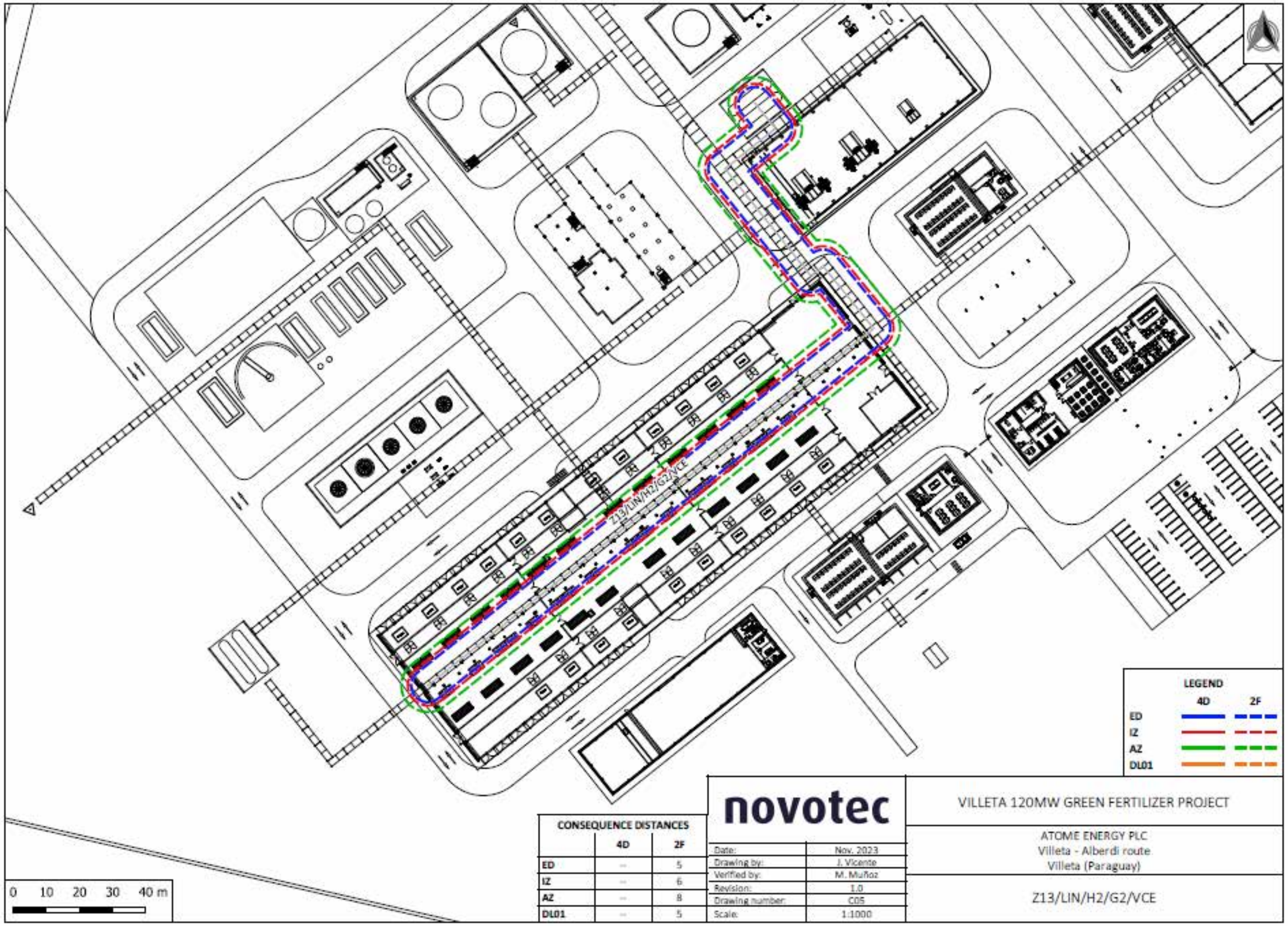


Figure 6.4.1.3.b-6
Jet Fire *Risk Areas* in H2 Tanks

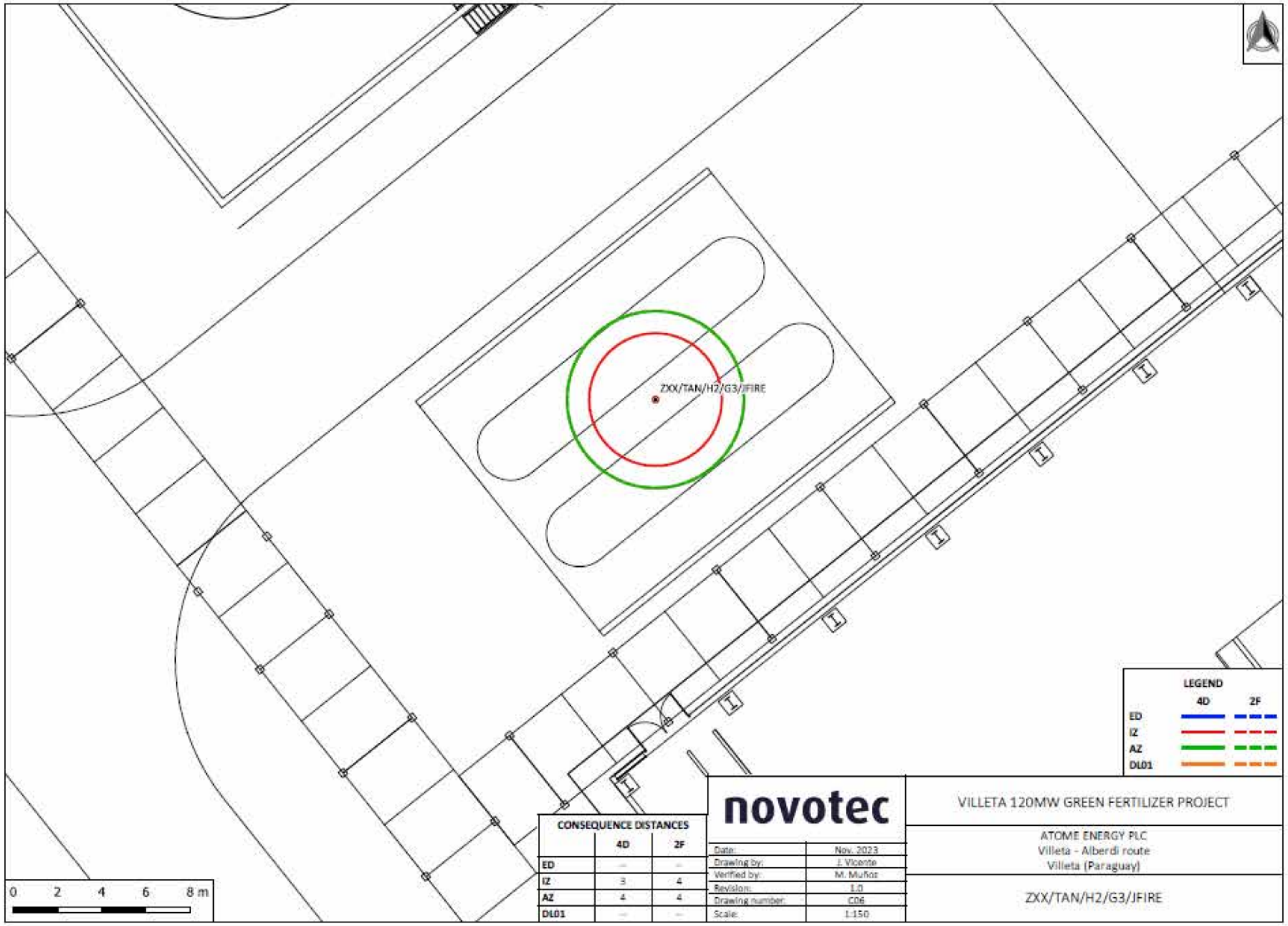


Figure 6.4.1.3.b-7
Physical Explosion Hazard (ECV) Areas in H2 Tanks

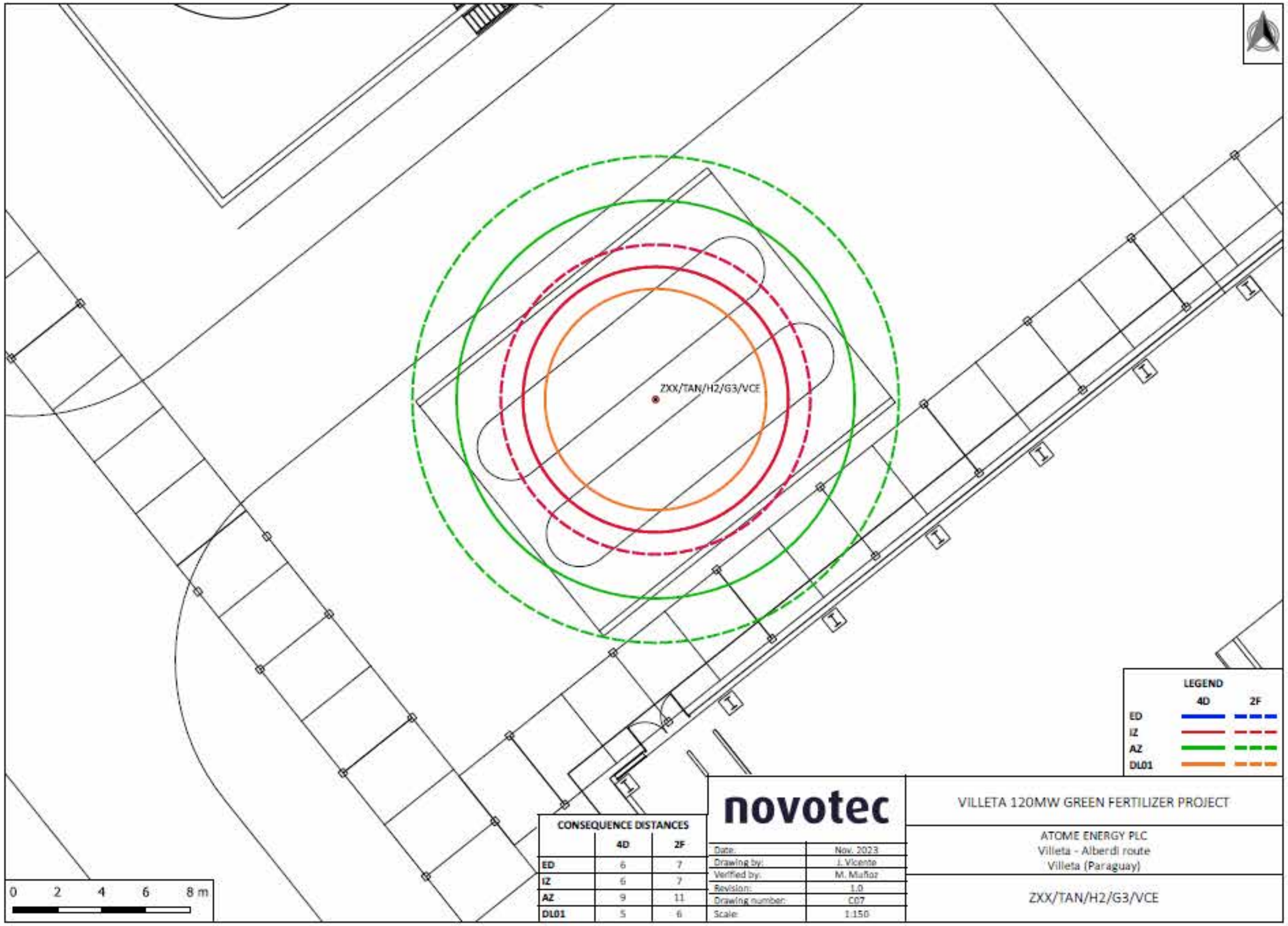


Figure 6.4.1.3.b-8
Flash Fire *Hazard Areas* in the H2 Tank Reserve Park

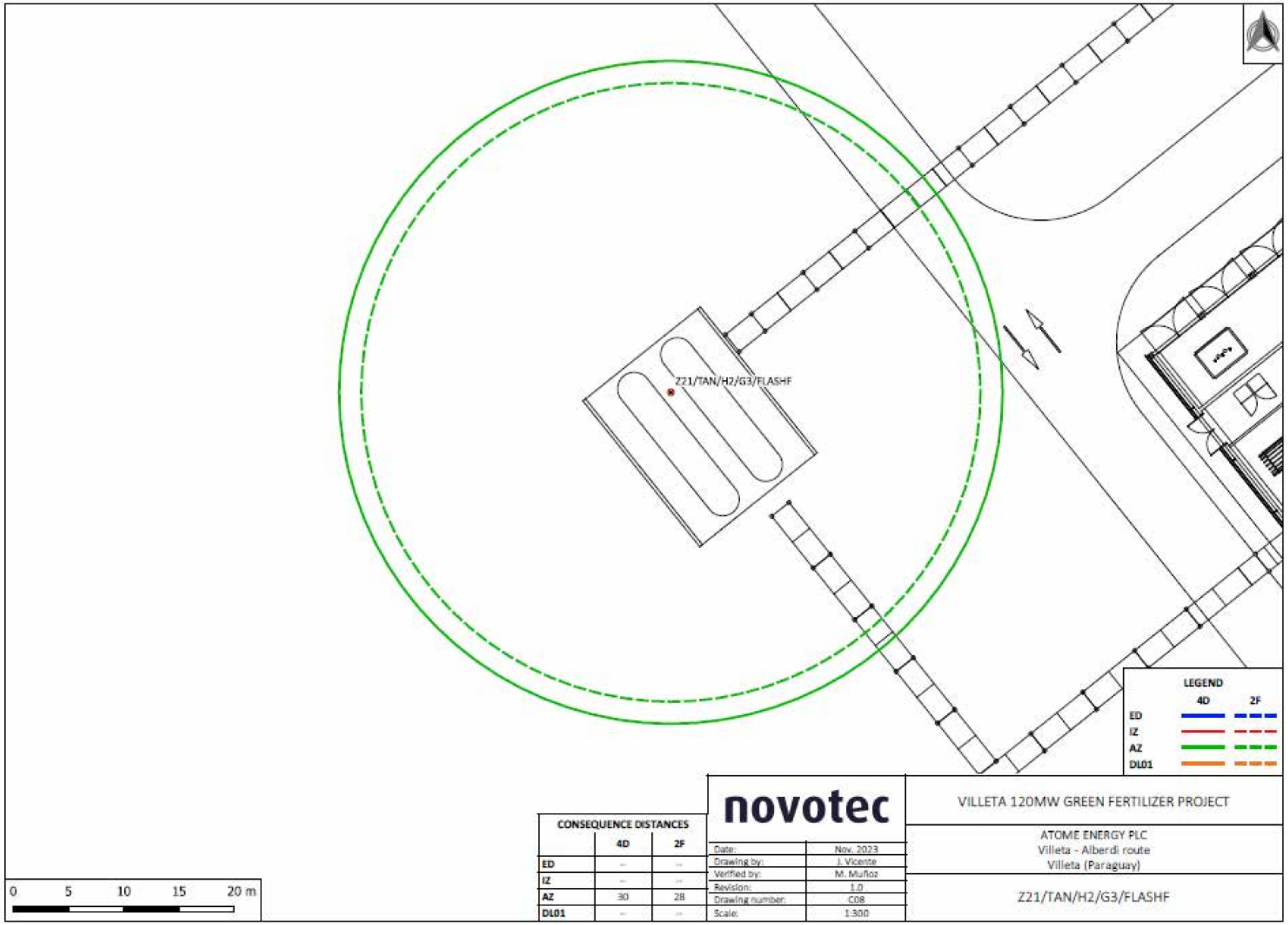


Figure 6.4.1.3.b-9
Physical Explosion Hazard (ECV) Areas in the H2 Tank Reserve Park

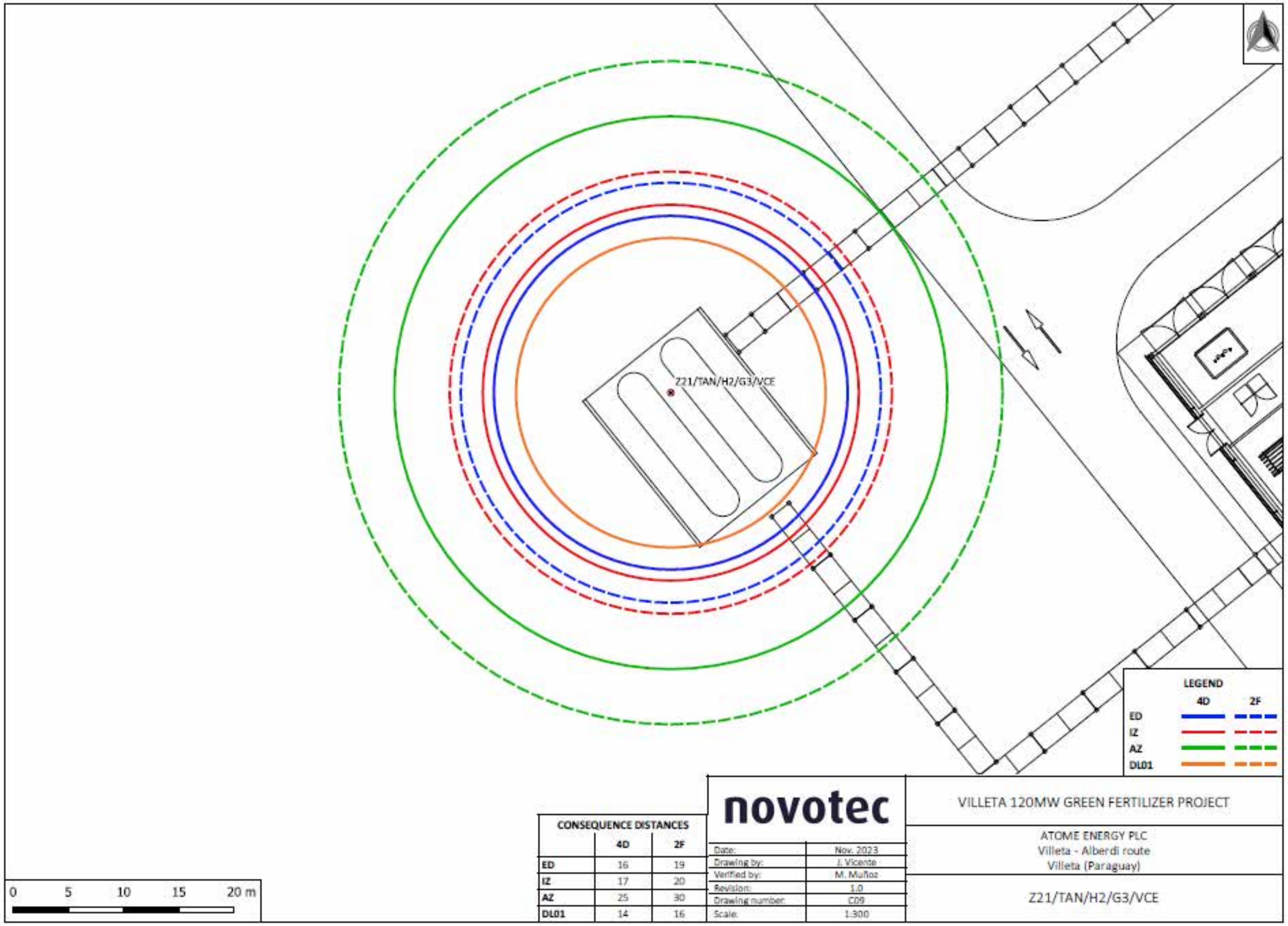


Figure 6.4.1.3.b-10
Jet Fire *Risk Areas* in the H2 Tank Reserve Park

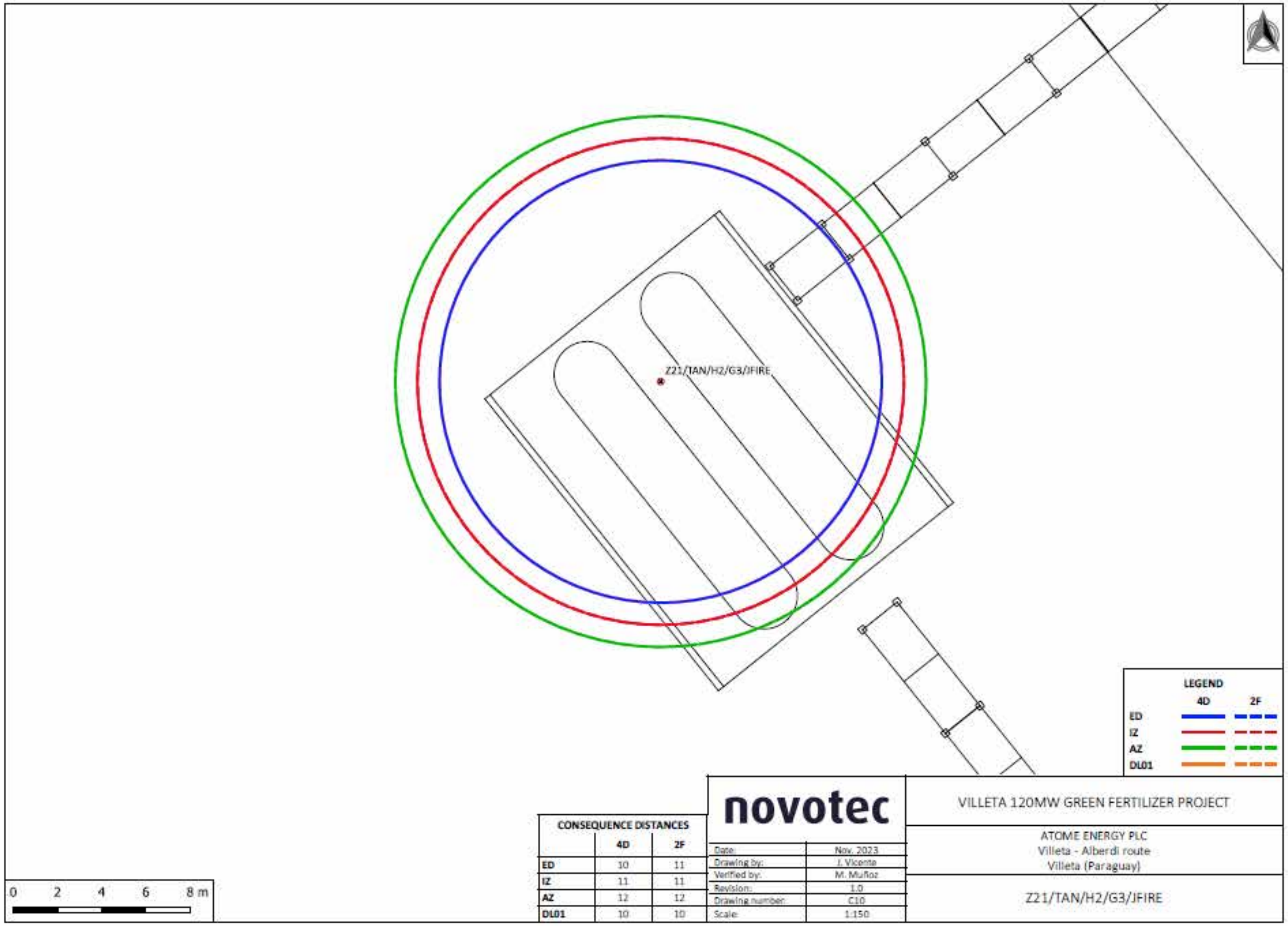


Figure 6.4.1.3.b-11
Flash Fire ***Risk Areas in Syngas Compressors***

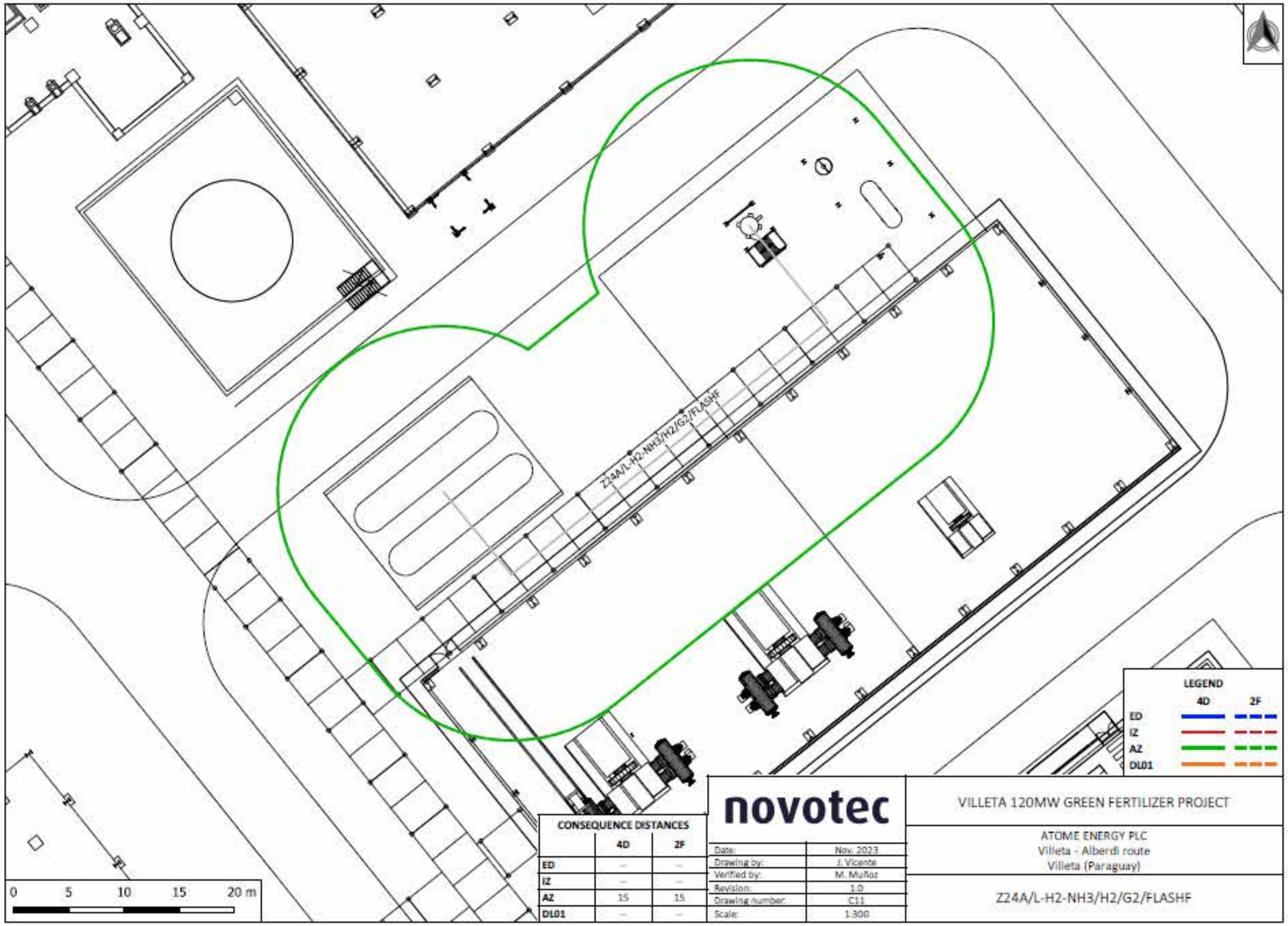


Figure 6.4.1.3.b-12
Physical Explosion (VCE) Hazard Areas in Syngas Compressors

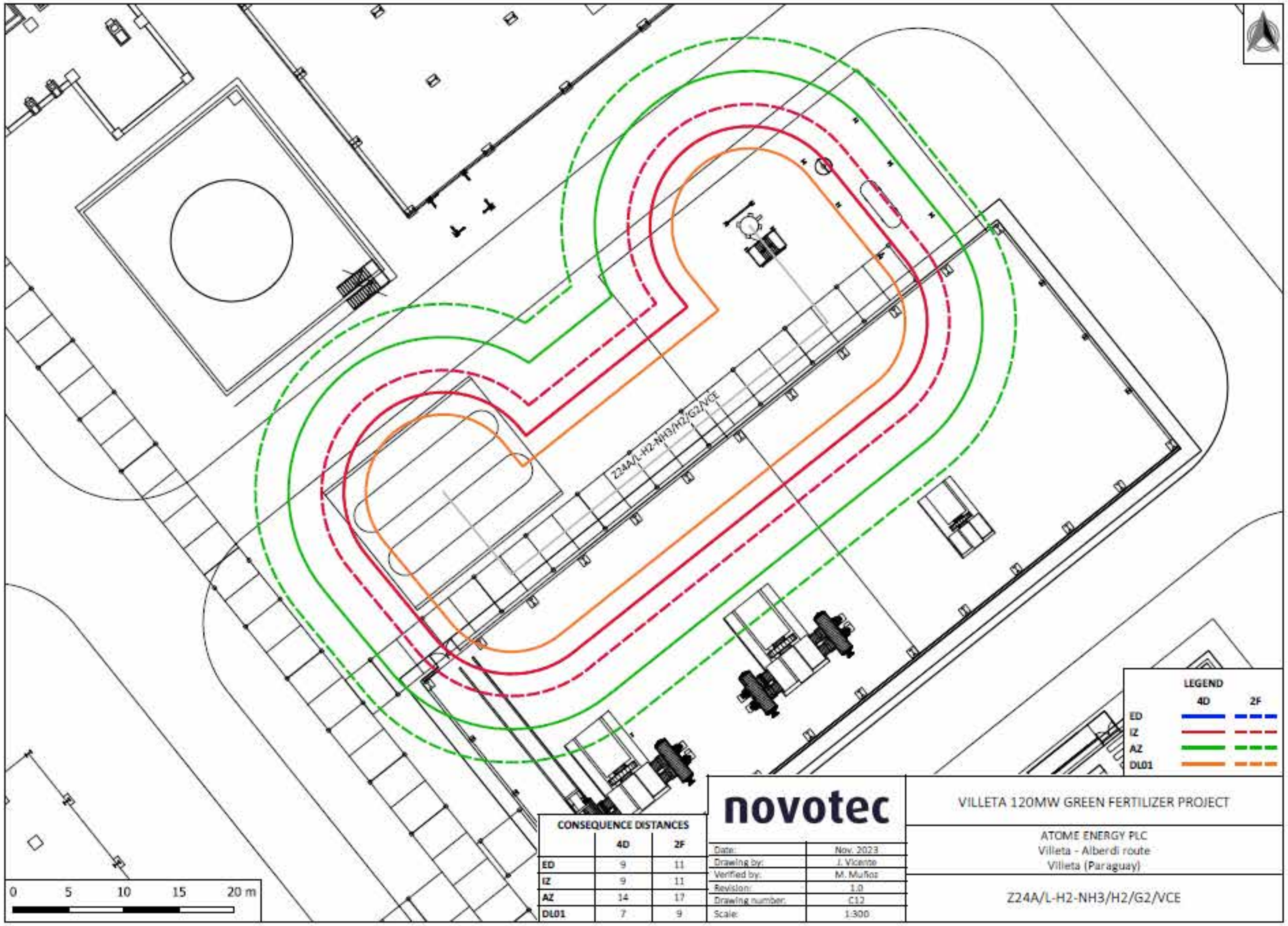


Figure 6.4.1.3.b-13
Jet Fire *Risk Areas in Syngas Compressors*

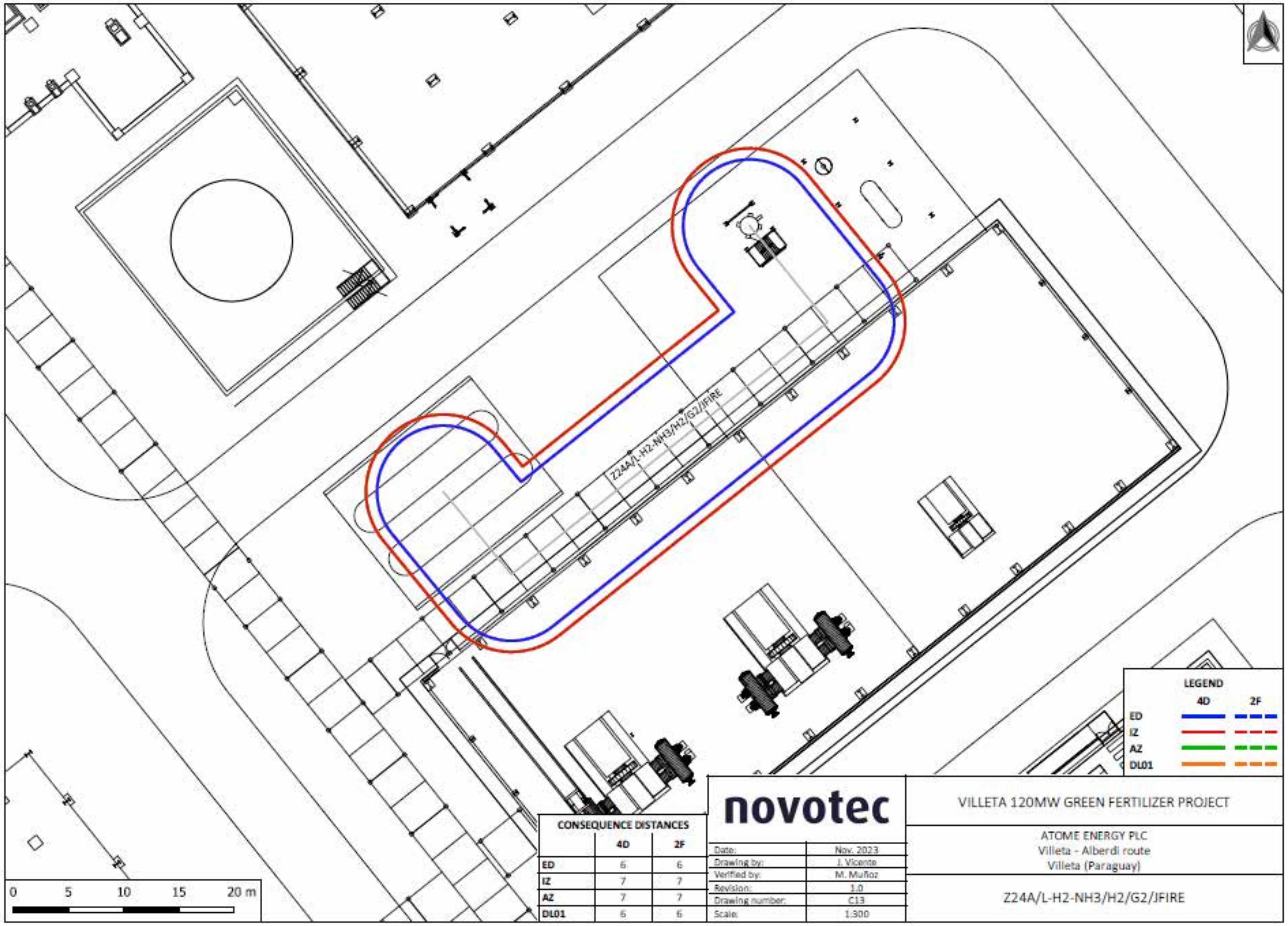
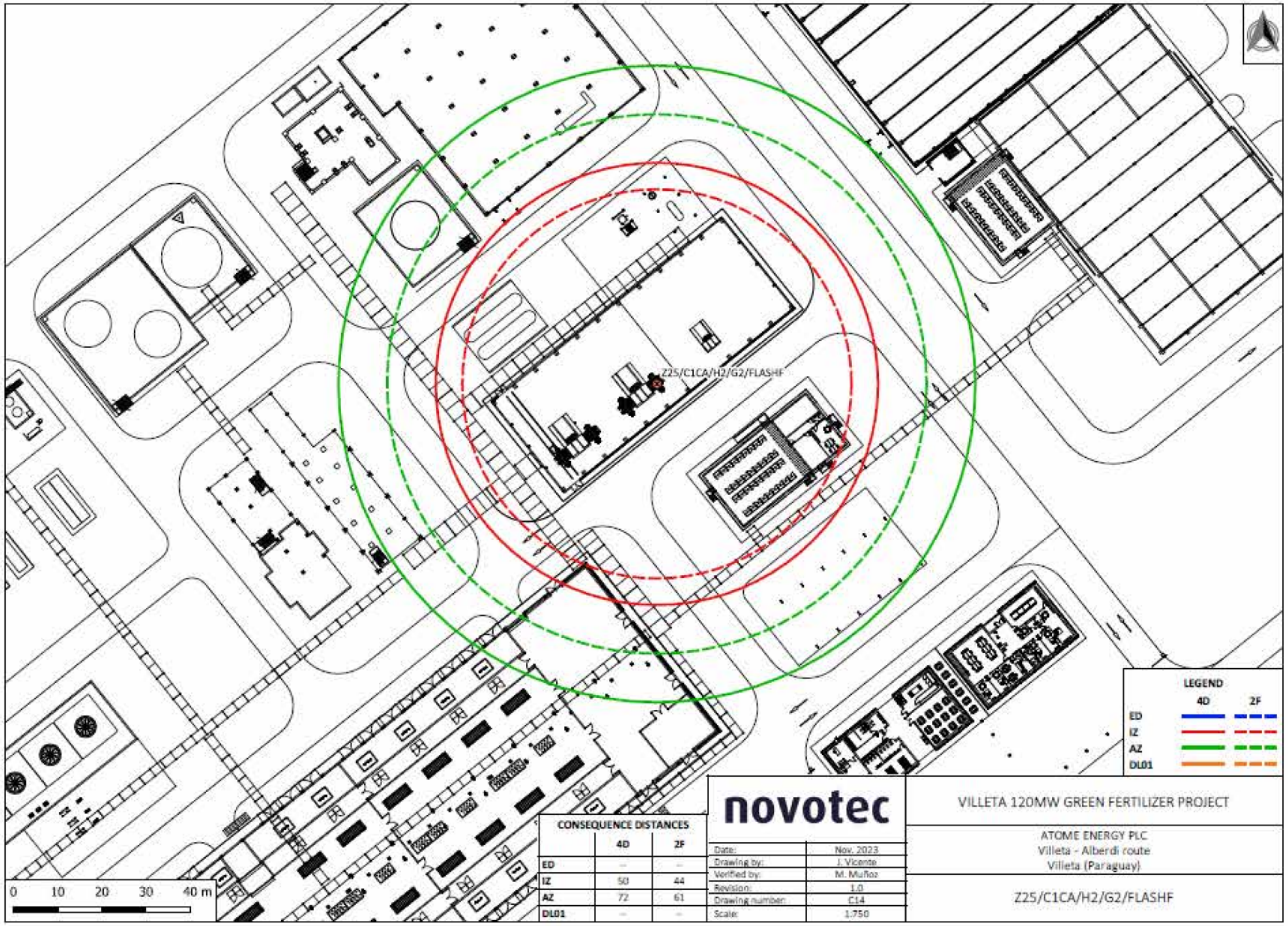
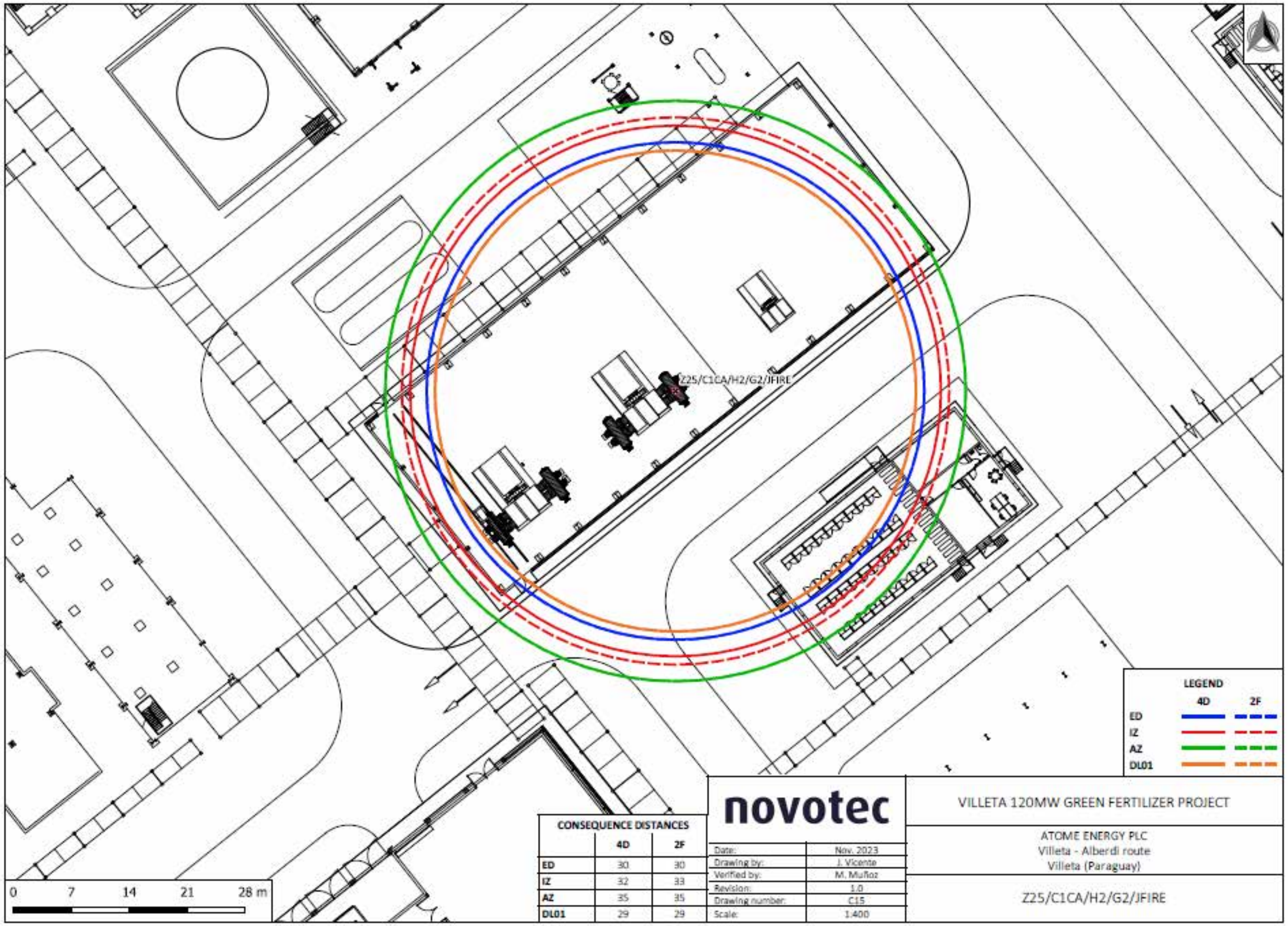


Figure 6.4.1.3.b-14
Flash fire hazard areas in the ammonia compressor of the NH3 Synthesis Unit



CONSEQUENCE DISTANCES	4D	2F
ED	–	–
IZ	50	44
AZ	72	61
DL01	–	–

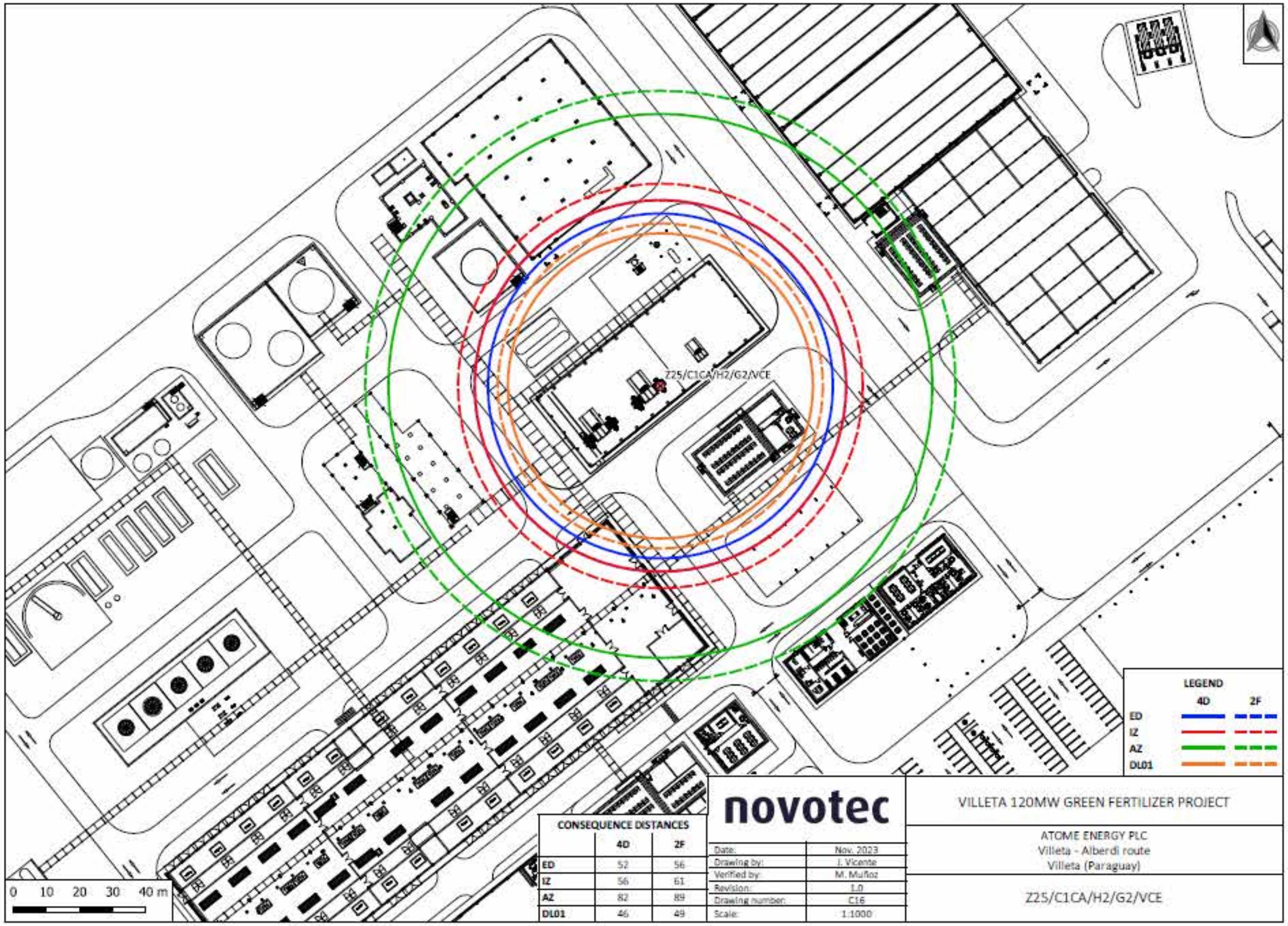
Figure 6.4.1.3.b-15
Jet Fire Risk Areas in the Ammonia Compressor of the NH3 Synthesis Unit



CONSEQUENCE DISTANCES	4D	2F
ED	30	30
IZ	32	33
AZ	35	35
DL01	29	29

Date:	Nov. 2023
Drawing by:	J. Vicente
Verified by:	M. Muñoz
Revision:	1.0
Drawing number:	C15
Scale:	1:400

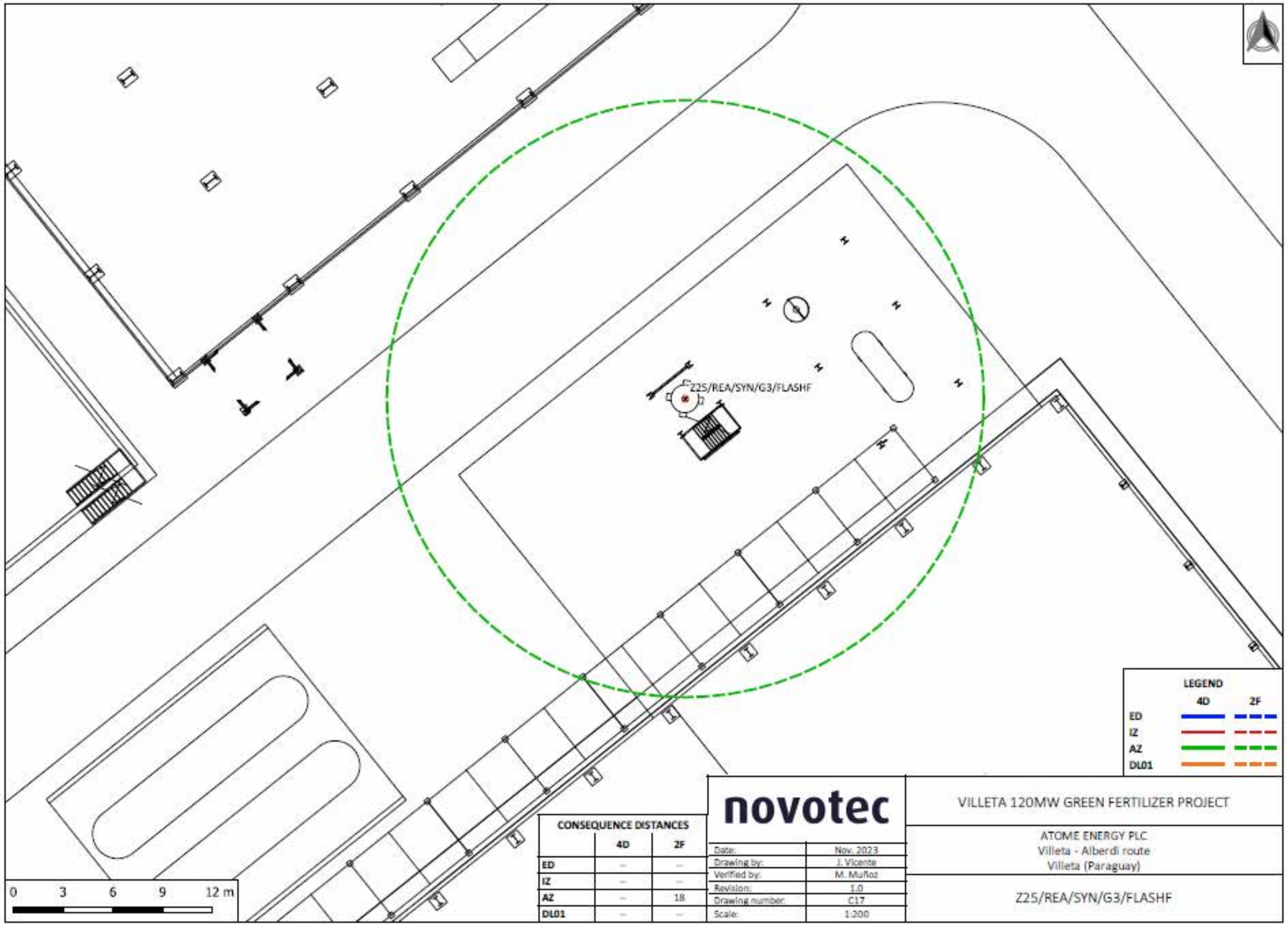
Figure 6.4.1.3.b-16
Physical Explosion (VCE) Hazard Areas in the Ammonia Compressor of the NH3 Synthesis Unit



CONSEQUENCE DISTANCES

	4D	2F
ED	52	56
IZ	56	61
AZ	82	89
DL01	46	49

Figure 6.4.1.3.b-17
Flash fire *hazard areas* in the NH3 Synthesis Unit reactor



CONSEQUENCE DISTANCES	4D	2F
ED	–	–
IZ	–	–
AZ	–	18
DL01	–	–

Date:	Nov. 2023
Drawing by:	J. Vicente
Verified by:	M. Muñoz
Revision:	1.0
Drawing number:	C17
Scale:	1:200

Figure 6.4.1.3.b-18
Jet Fire *Risk Areas* at the NH3 Synthesis Unit Reactor

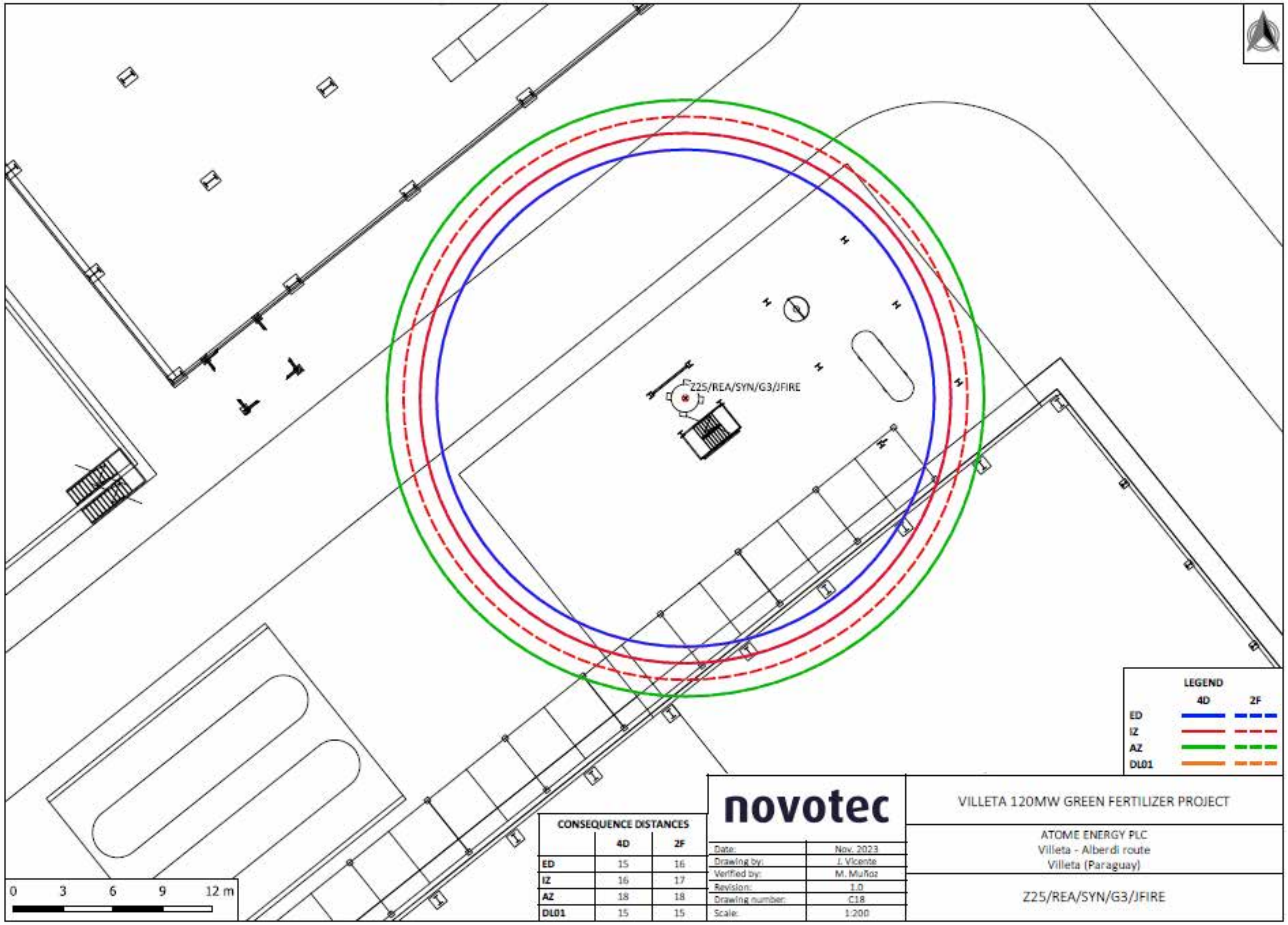
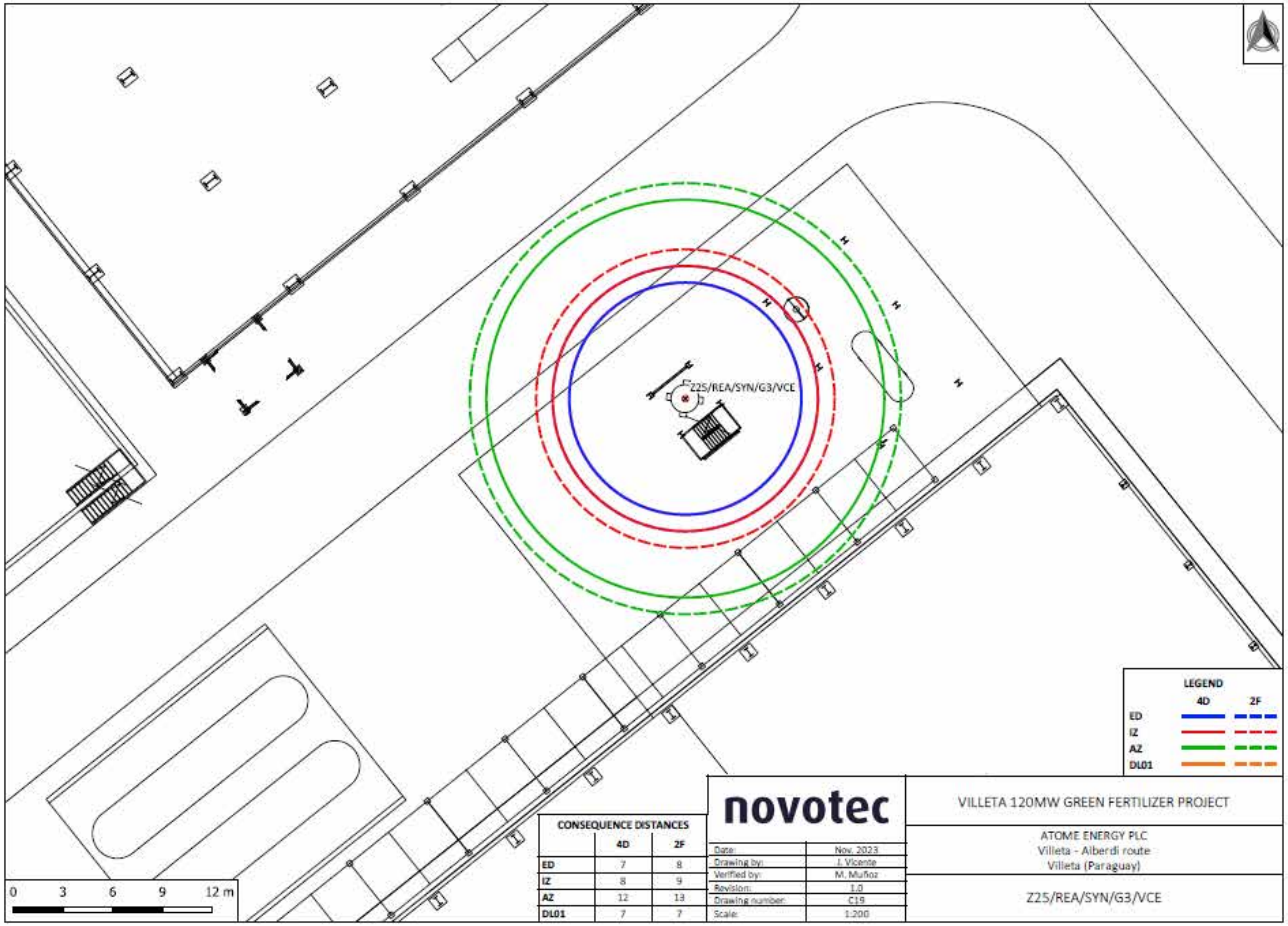


Figure 6.4.1.3.b-19
Physical Explosion Hazard (VCE) Areas in the NH3 Synthesis Unit Reactor



CONSEQUENCE DISTANCES	4D	2F
ED	7	8
IZ	8	9
AZ	12	13
DL01	7	7

Figure 6.4.1.3.b-20
Flash fire *hazard areas* in the syngas line of the NH3 Synthesis Unit

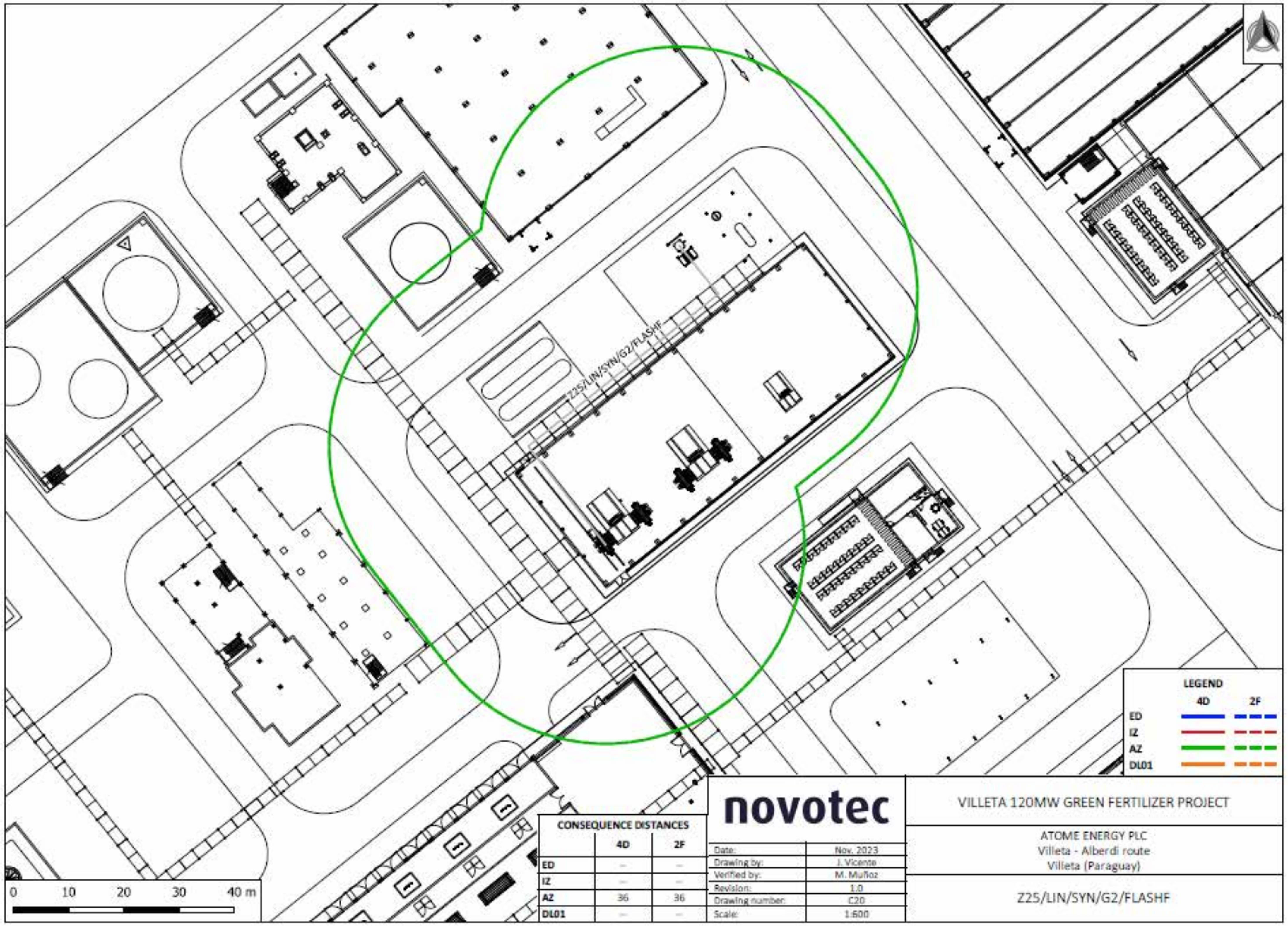


Figure 6.4.1.3.b-21
Physical Explosion Hazard (VCE) Areas in the Syngas Line of the NH 3 Synthesis Unit

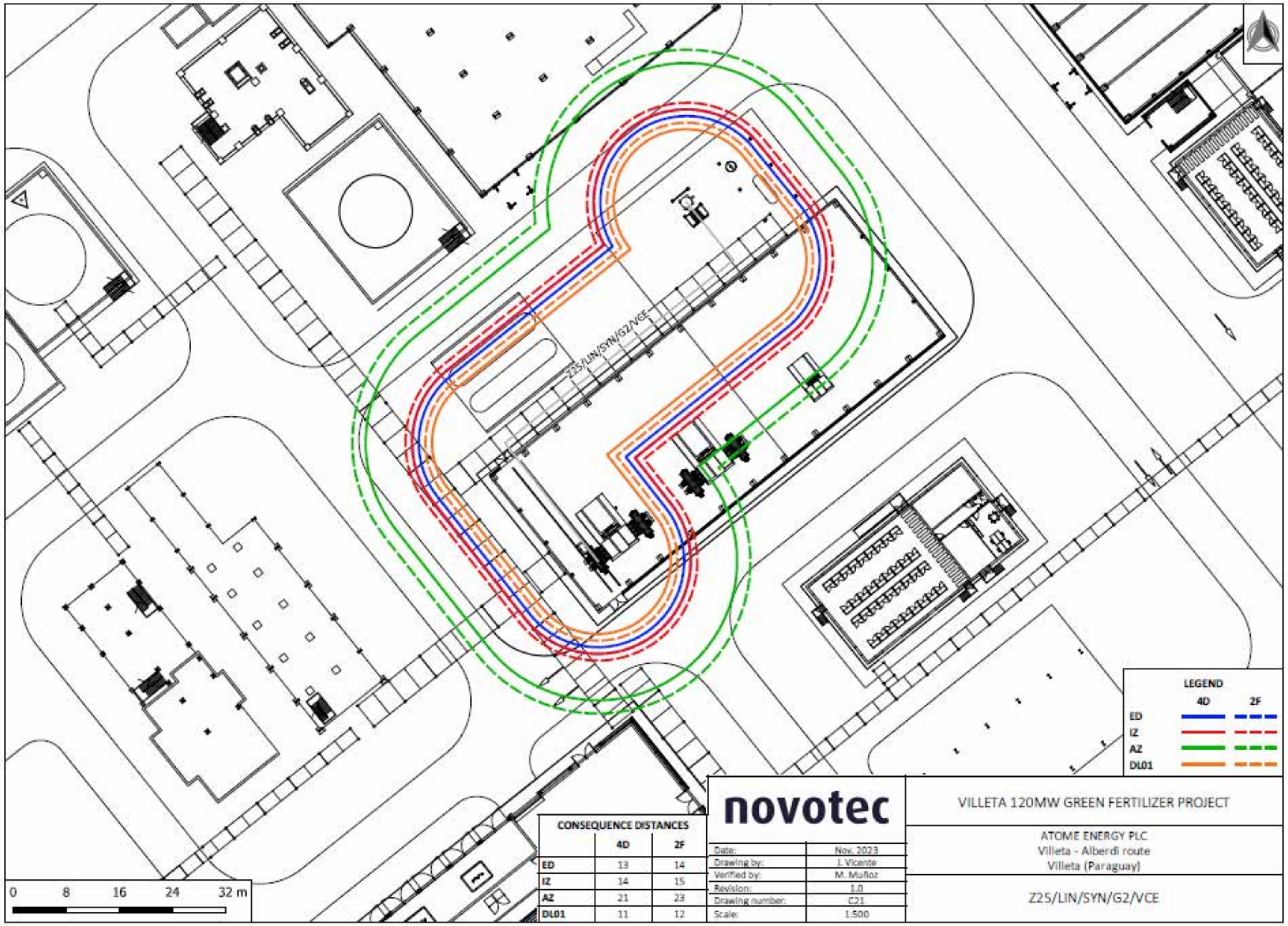
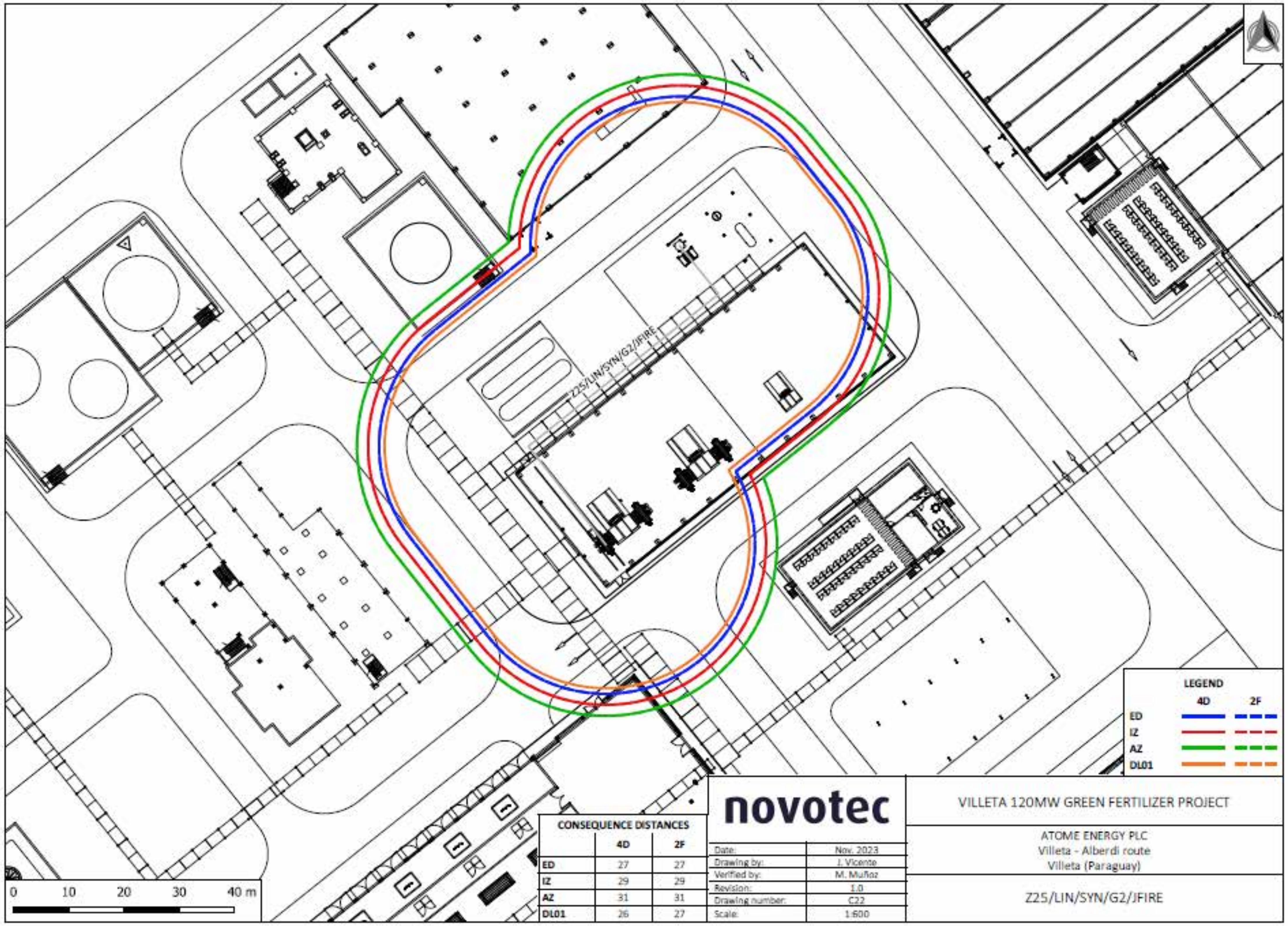
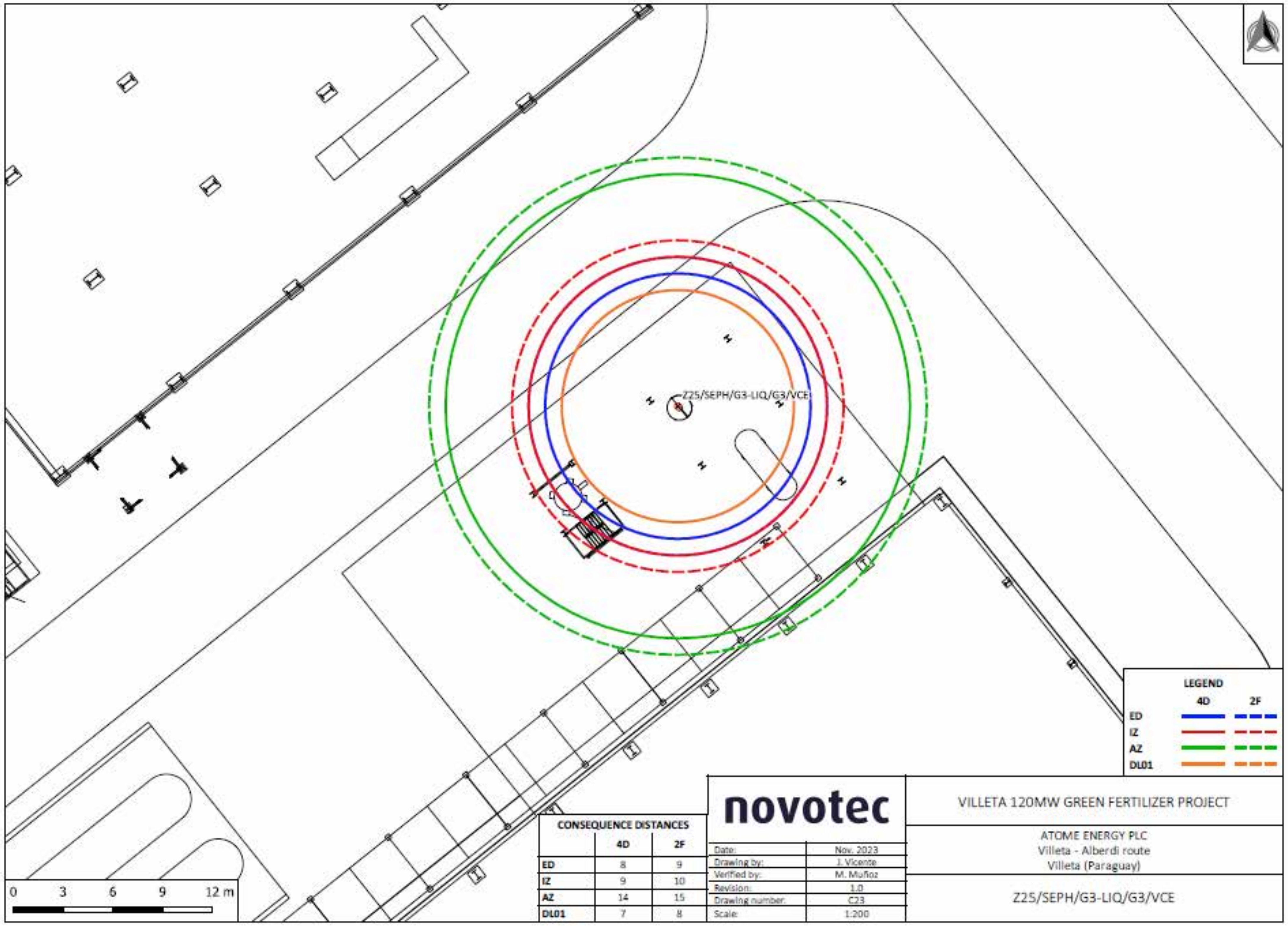


Figure 6.4.1.3.b-22
Jet Fire *Risk Areas* in the NH3 Synthesis Unit Syngas Line



CONSEQUENCE DISTANCES	4D	2F
ED	27	27
IZ	29	29
AZ	31	31
DL01	26	27

Figure 6.4.1.3.b-23
Physical Explosion Hazard (VCE) Areas in the NH3 Synthesis Unit's High Pressure NH3 Separator



CONSEQUENCE DISTANCES	4D	2F
ED	8	9
IZ	9	10
AZ	14	15
DL01	7	8

Date:	Nov. 2023
Drawing by:	J. Vicente
Verified by:	M. Muñoz
Revision:	1.0
Drawing number:	C23
Scale:	1:200

Figure 6.4.1.3.b-24
Jet Fire *Risk Areas* in the High Pressure NH3 Separator of the NH3 Synthesis Unit

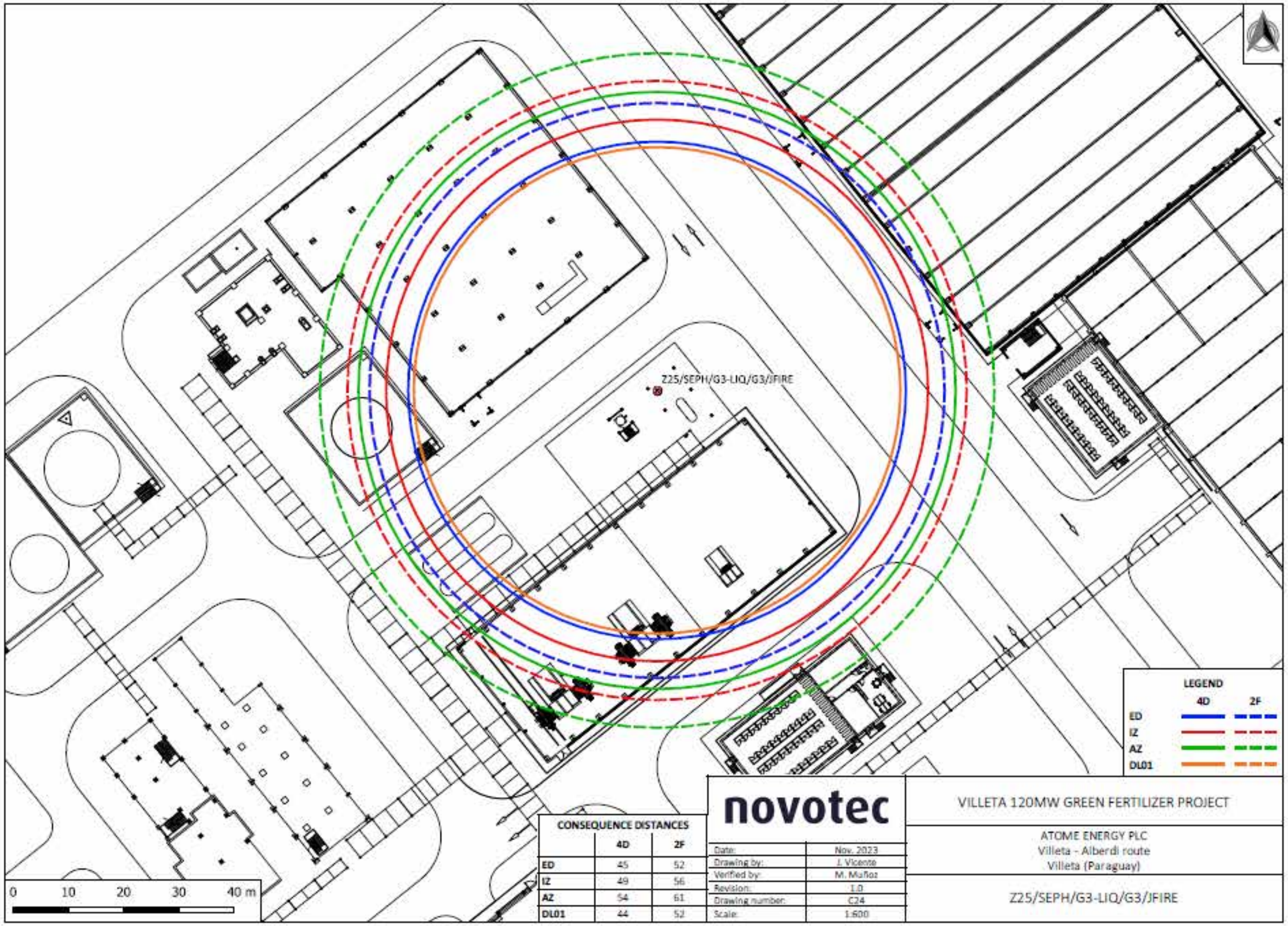


Figure 6.4.1.3.b-25
Flash fire *hazard areas* in the NH3 separator under atmospheric conditions of the NH3 Synthesis Unit

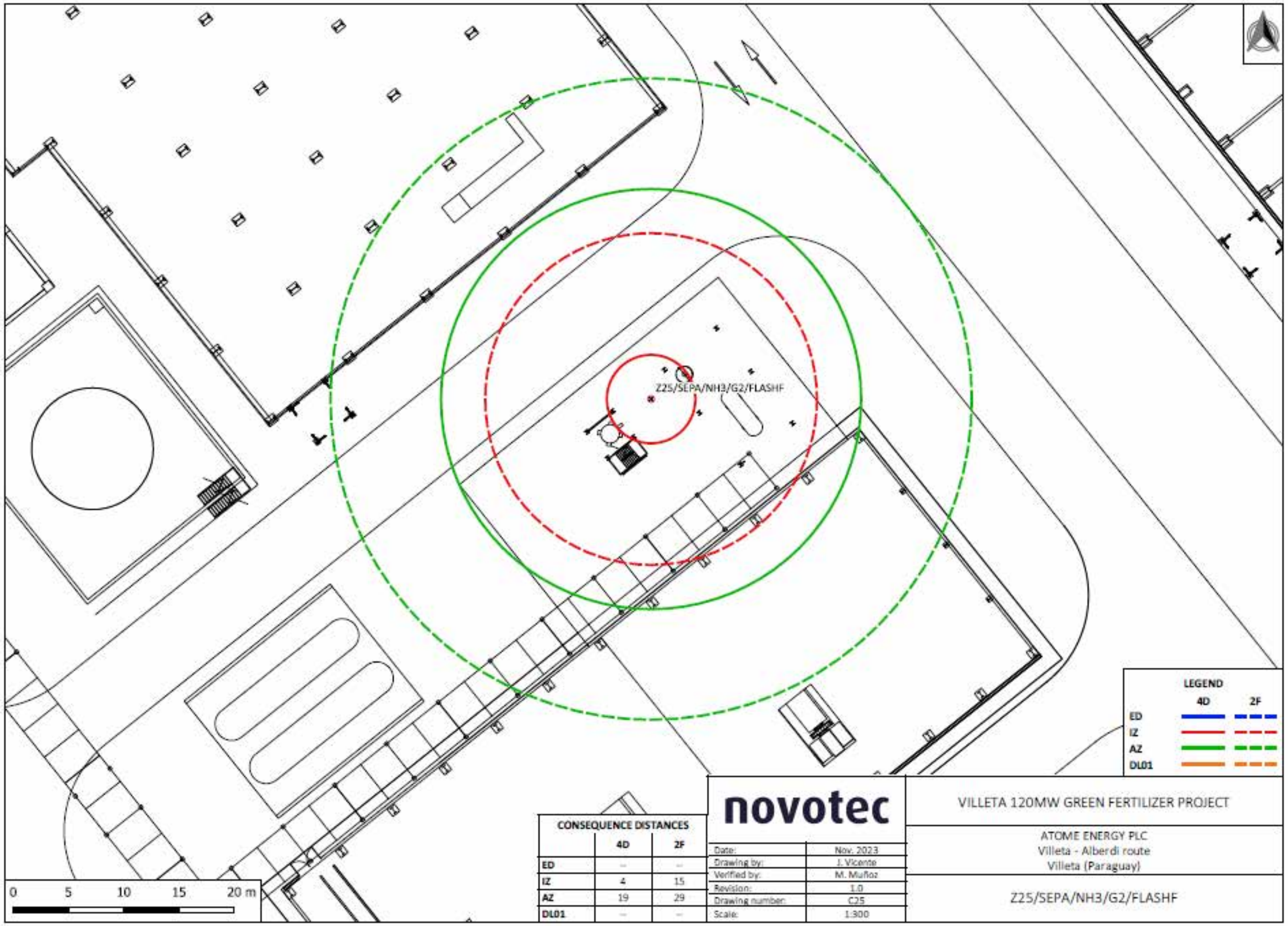


Figure 6.4.1.3.b-26
Jet fire *hazard areas* in the NH3 separator under atmospheric conditions of the NH3 Synthesis Unit

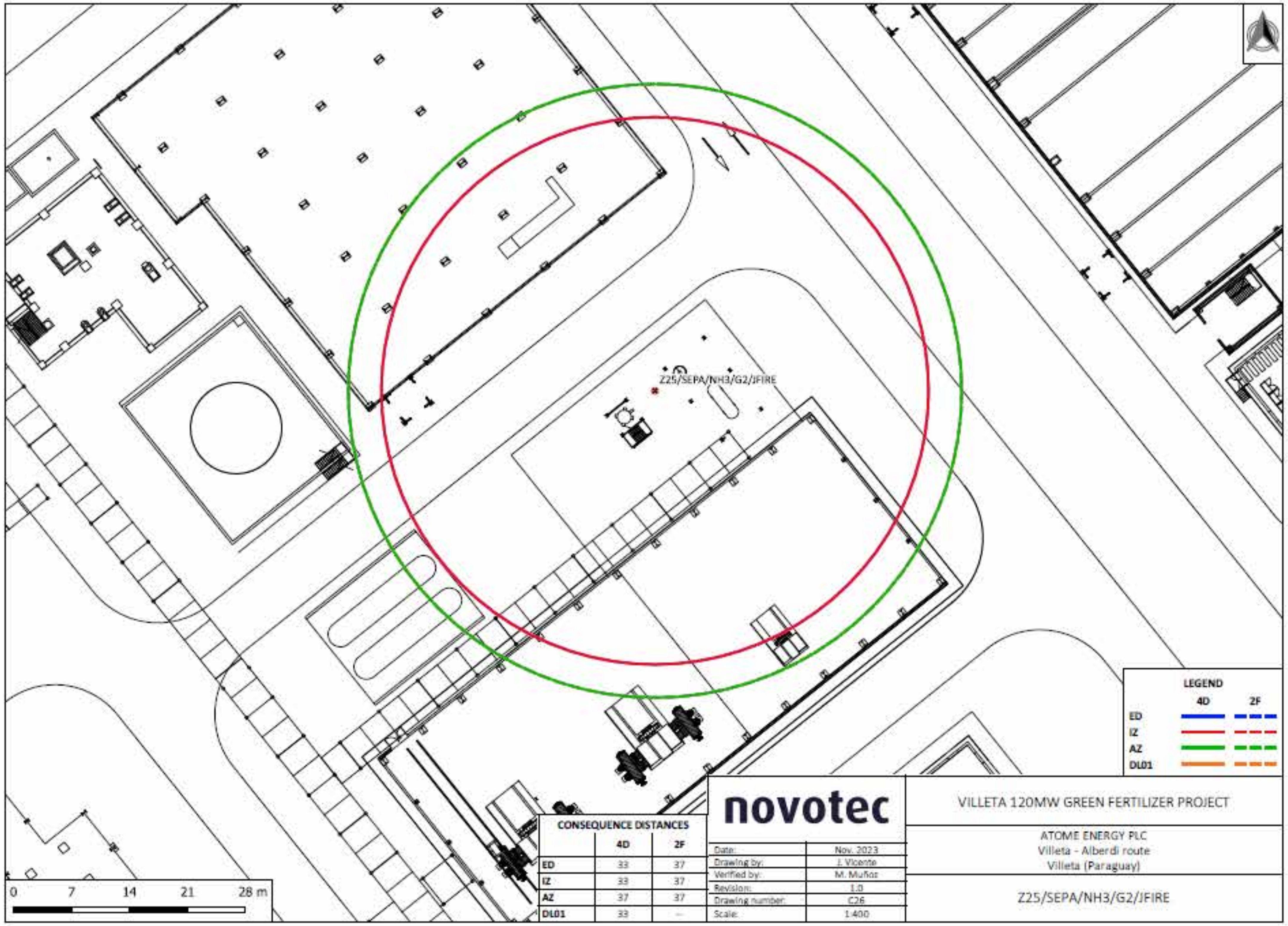
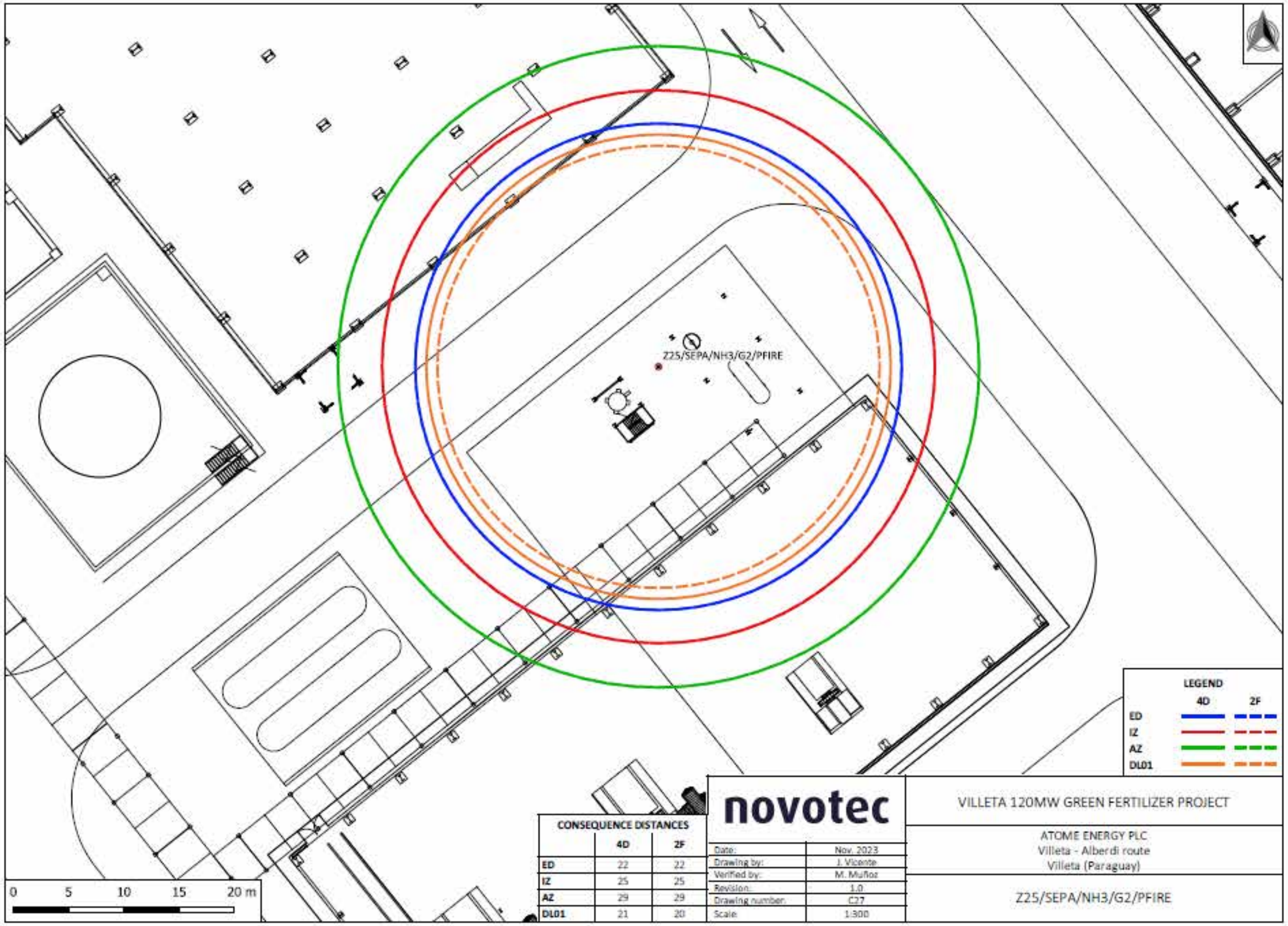


Figure 6.4.1.3.b-27
Pool fire *hazard areas* in the NH3 separator under atmospheric conditions of the NH3 Synthesis Unit



CONSEQUENCE DISTANCES	4D	2F
ED	22	22
IZ	25	25
AZ	29	29
DL01	21	20

Date:	Nov. 2023
Drawing by:	J. Vicente
Verified by:	M. Muñoz
Revision:	1.0
Drawing number:	C27
Scale:	1:300

Figure 6.4.1.3.b-28
Flash Fire *Hazard Areas* in the NH3 Buffer Tank

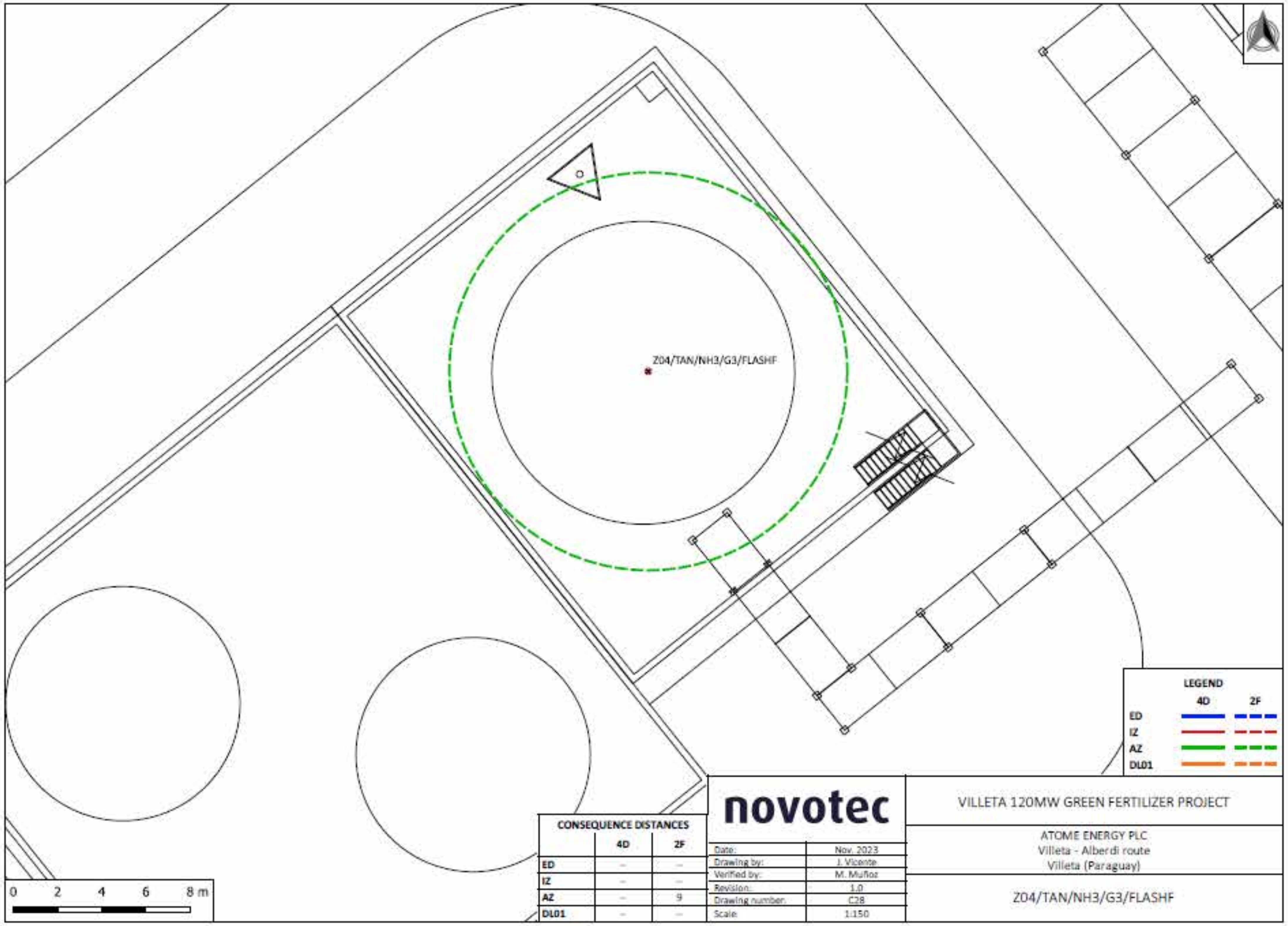


Figure 6.4.1.3.b-29
Jet Fire *Hazard Areas* in the NH_3 Buffer Tank

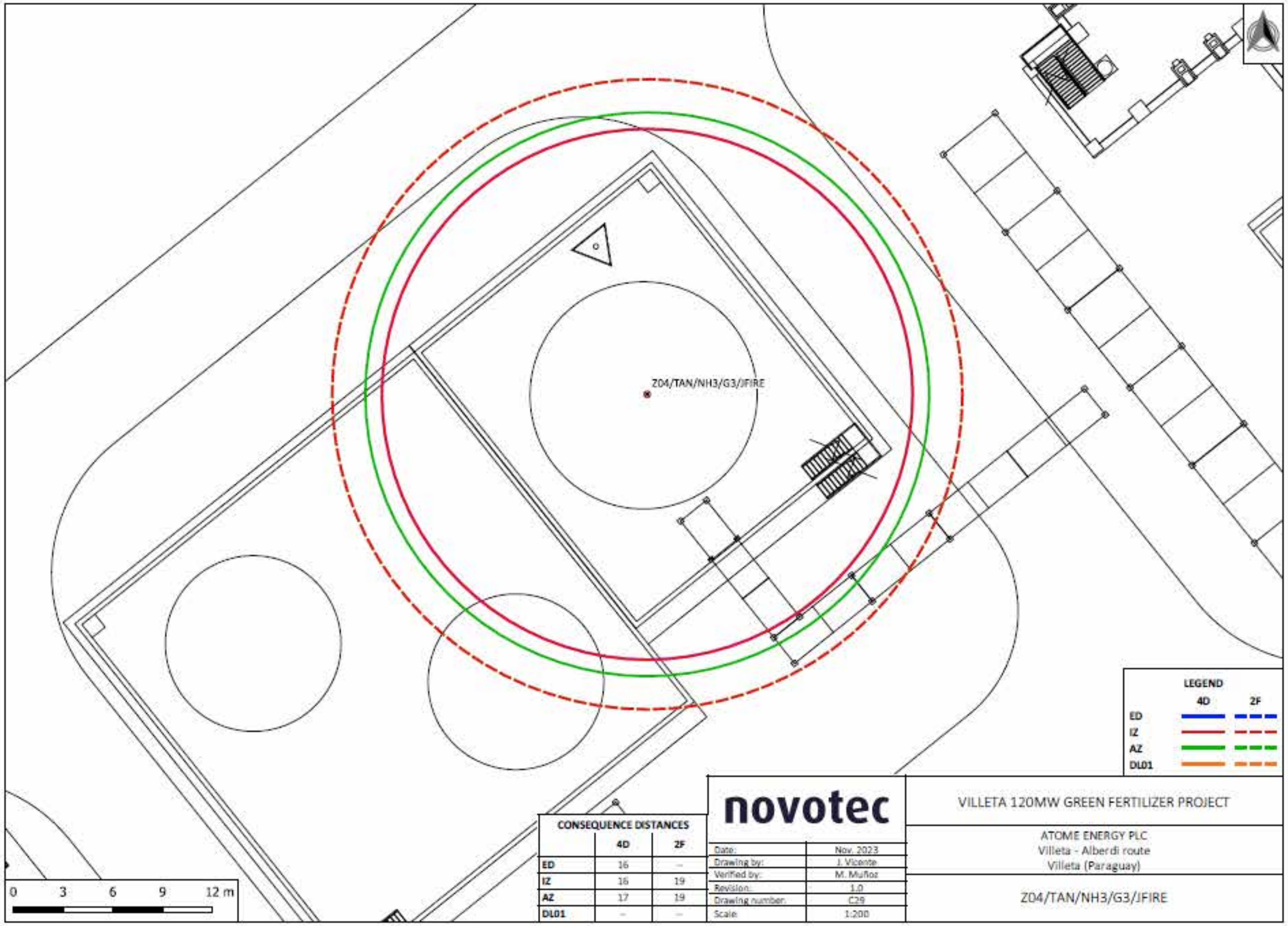
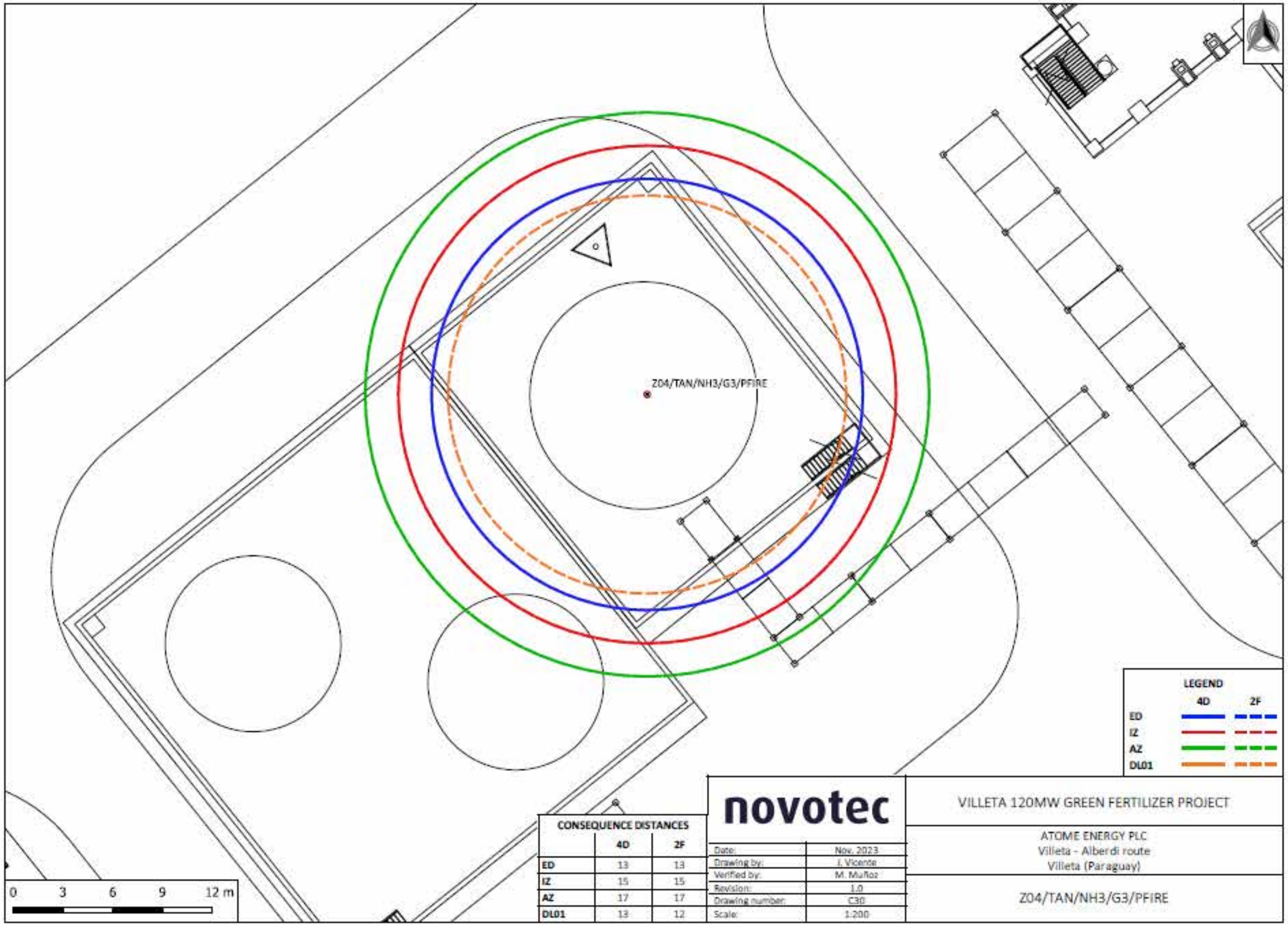


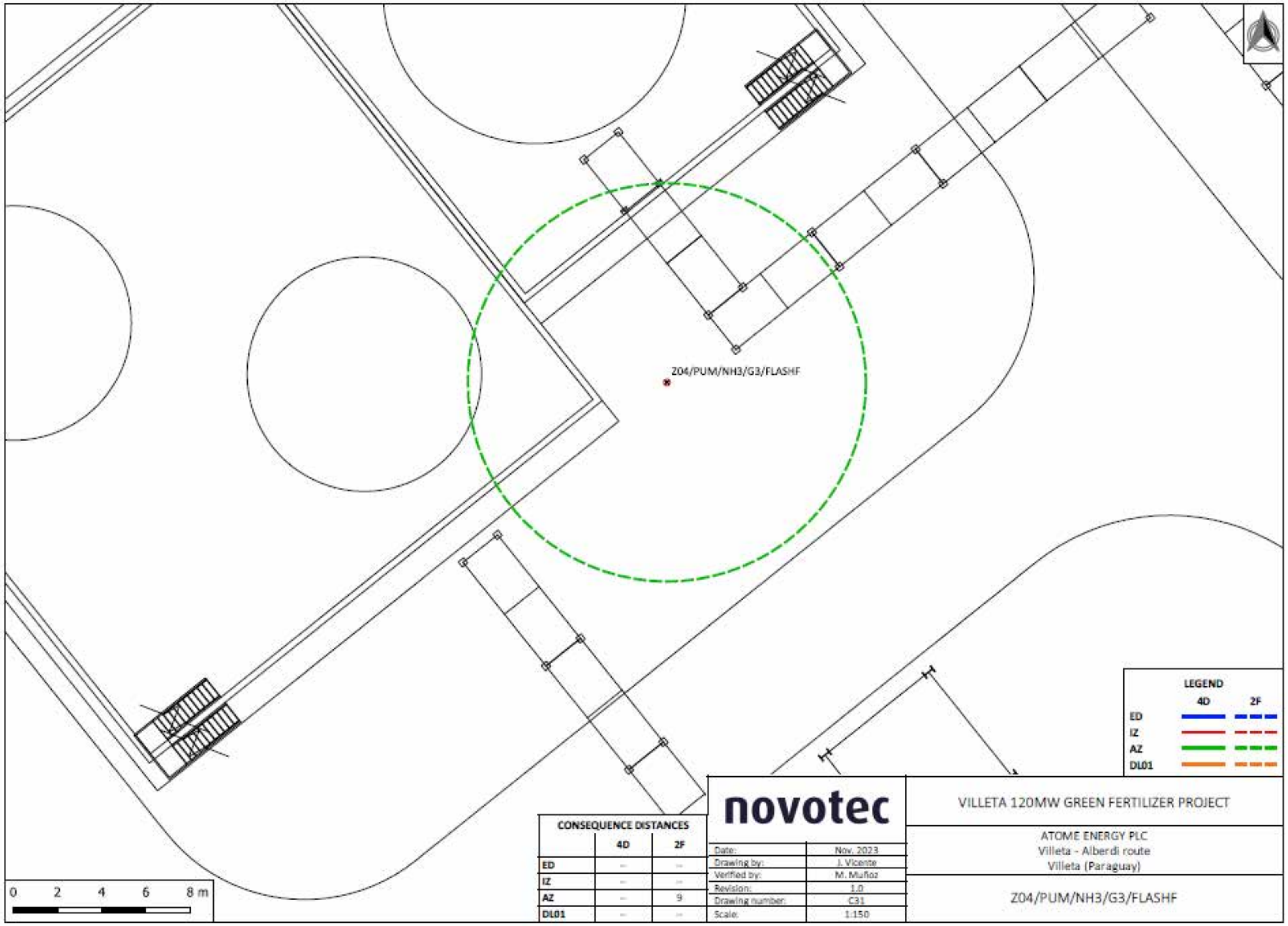
Figure 6.4.1.3.b-30
Pool Fire Hazard Areas in the NH3 Buffer Tank



CONSEQUENCE DISTANCES	4D	2F
ED	13	13
IZ	15	15
AZ	17	17
DL01	13	12

Date:	Nov. 2023
Drawing by:	I. Vicente
Verified by:	M. Muñoz
Revision:	1.0
Drawing number:	C30
Scale:	1:200

Figure 6.4.1.3.b-31
Flash Fire *Hazard Areas* on NH 3 Buffer Pump



CONSEQUENCE DISTANCES	4D	2F
ED	--	--
IZ	--	--
AZ	--	9
DL01	--	--

Date:	Nov. 2023
Drawing by:	J. Vicente
Verified by:	M. Muñoz
Revision:	1.0
Drawing number:	C31
Scale:	1:150

Figure 6.4.1.3.b-32
Jet Fire *Hazard Areas* in the NH 3 Buffer Pump

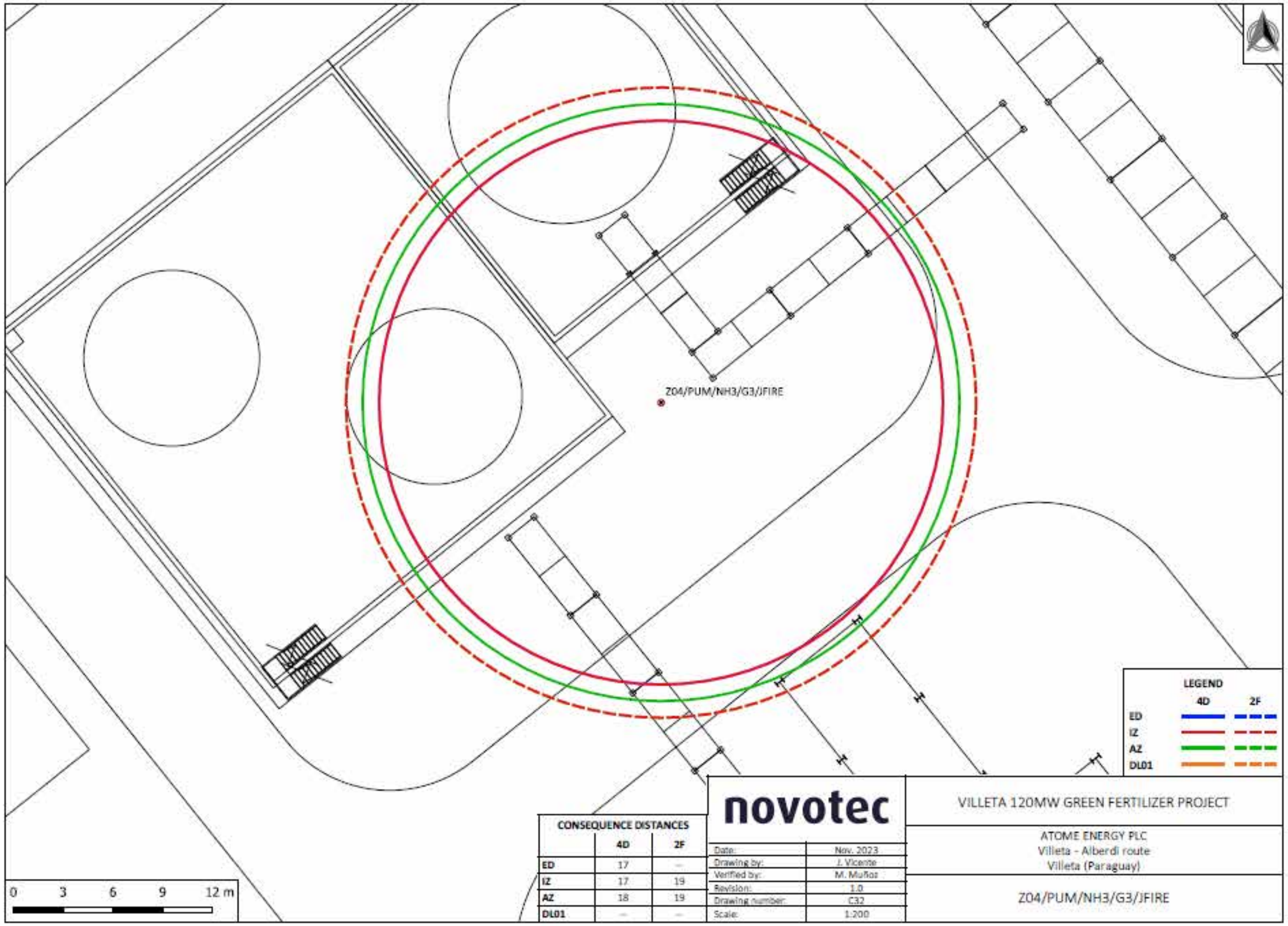
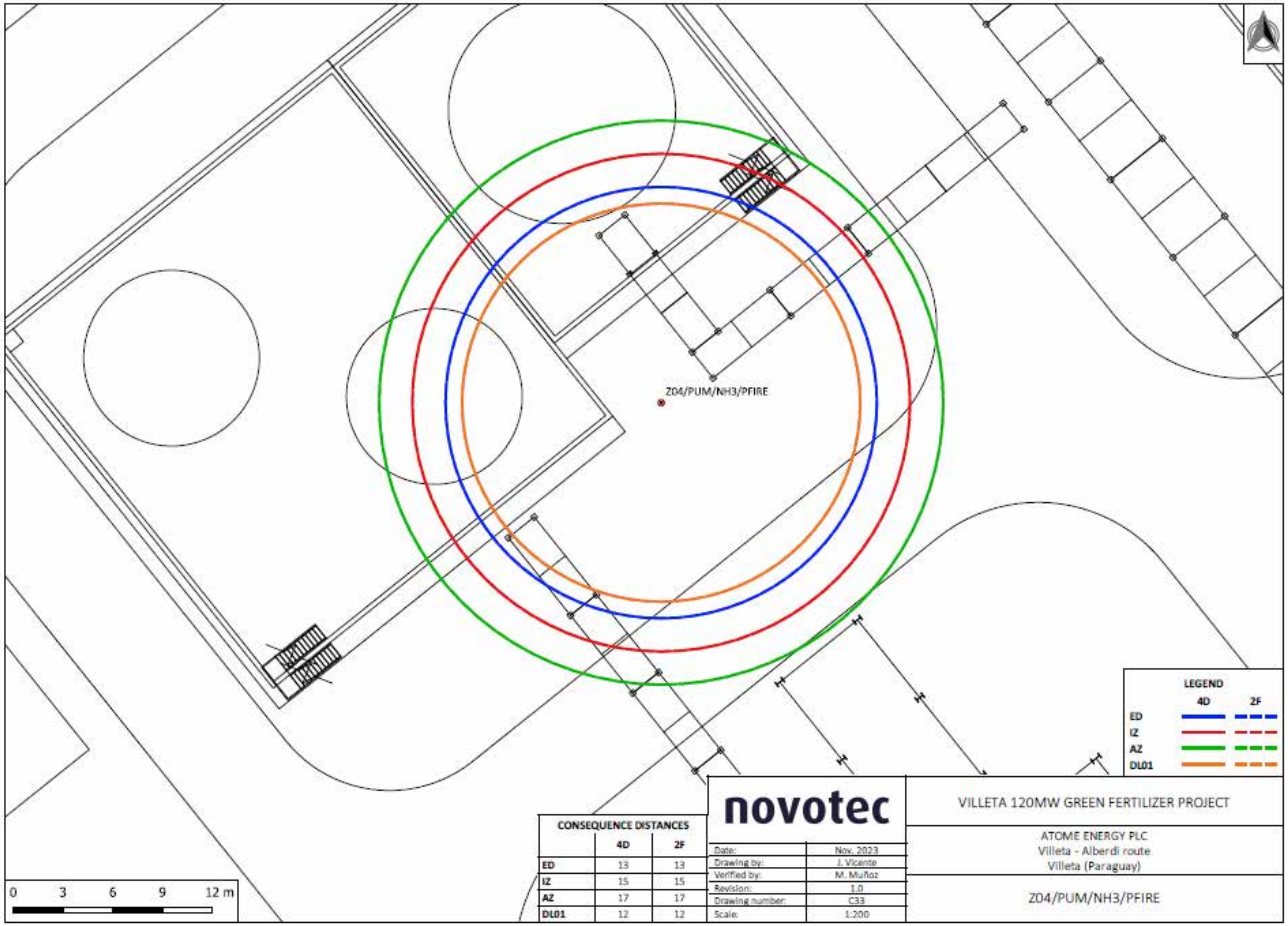
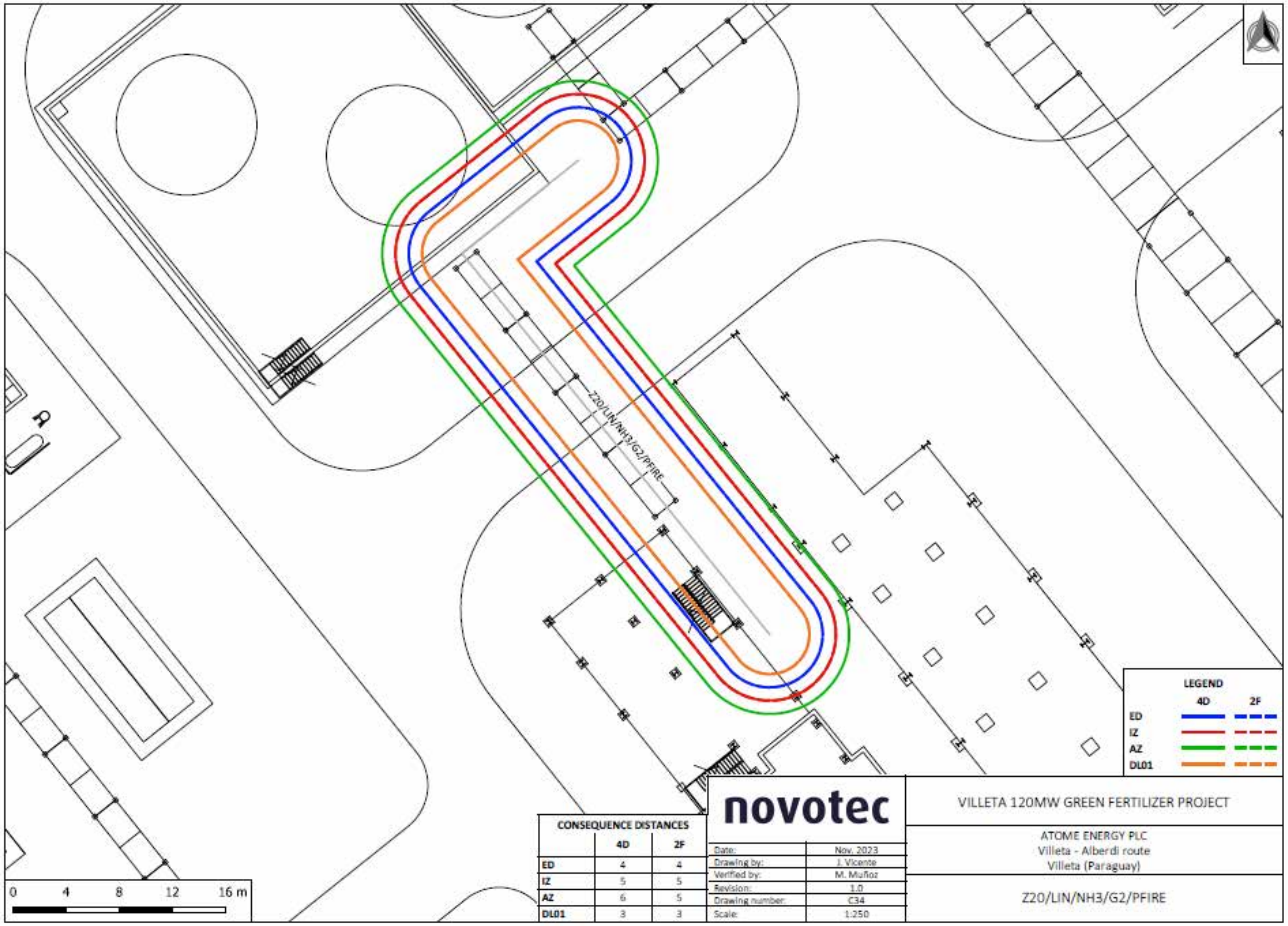


Figure 6.4.1.3.b-33
Pool Fire *Hazard Areas* at the NH3 Buffer Pump



CONSEQUENCE DISTANCES	4D	2F
ED	13	13
IZ	15	15
AZ	17	17
DL01	12	12

Figure 6.4.1.3.b-34
Pool Fire *Risk Areas* on the Nitric Acid (AN) Plant Line



CONSEQUENCE DISTANCES

	4D	2F
ED	4	4
IZ	5	5
AZ	6	5
DL01	3	3

Figure 6.4.1.3.b-35
Pool Fire *Hazard Areas* on the Ammonium Nitrate Solution (SNA) Plant Line